

PART I. EXECUTIVE SUMMARY/OVERVIEW

The purpose of this *State Water Quality Assessment Report*, otherwise known as the Section 305(b) Report, is to assess and report on the extent to which beneficial uses of the state's rivers, streams, lakes, reservoirs, and wetlands are met. Section 305(b) of the Clean Water Act requires states to submit this assessment report every two years; therefore, the information presented in this report is for the reporting period of 1994-1995. This report is not a trends report, nor should the data or information in this report be used to assess water quality trends. Factors which complicate and prohibit comparisons between reporting years include changes in the number of sites and the quality of data upon which assessment information is based, and changes to the estimated river and stream miles. For example, during this reporting cycle, estimated river and stream miles increased from 11,868 miles to 53,989 miles, using the Environmental Protection Agency's (EPA) River Reach File Version 3.0 (RF3) .

The North Dakota Department of Health (hereafter referred to as the Health Department) currently recognizes 219 lakes and reservoirs for water quality assessment purposes. Of this total, there are 131 manmade reservoirs and 88 natural lakes with a combined surface acreage of 538,544 acres.

Based on EPA's RF3, there are 53,989 miles of rivers and streams in the state. When compared to the 1994 report, this reflects an increase of over 42,000 miles. This increase in total miles of rivers and streams is due to the increased level of detail with which RF3 is derived. RF3 is derived from the U. S. Geological Survey's (USGS) 1:100,000 scale Digital Line Graph (DLG) data. The DLG data contains all hydrologic features found on paper maps of the same scale.

Historically, water quality monitoring conducted by the Health Department consisted of a statewide network of chemical monitoring stations. Many of these stations were located immediately below point source discharges or near the confluences of major streams. The primary purpose of this historic monitoring program was to assess the general chemical character of the state's rivers and streams and, to the extent practical, assess point source discharge compliance with *State Water Quality Standards*. While effective in its original purpose, this historic strategy was largely ineffective in assessing trends in water quality across the state, nor did it provide enough spatial resolution necessary to conduct beneficial use assessments for any significant number of stream miles in the state. Where data was available, it was still difficult to make beneficial use assessments, since much of it was only indirectly related to beneficial use impairment.

In response to this growing need for better water quality assessment information, the Health Department initiated a biological monitoring program in 1993 to run through 1994. This program, a cooperative effort with the Minnesota Pollution Control Agency and the USGS's Red River National Water Quality Assessment Program, involved approximately 100 sites in the Red River Basin. The result of this initial program was development of an Index of Biotic Integrity (IBI) for fish in the Red River Basin. This program continued in 1995, with an additional 50 biological monitoring sites in the Upper Red River Basin, including the Sheyenne River and its

tributaries. Biological monitoring was also expanded in 1995 to include macroinvertebrate sampling. This “basin approach” to biological monitoring allowed for more intensive water quality monitoring and assessment. The result has been better resolution in the Health Department’s monitoring program and a direct assessment of aquatic life use support for the state’s rivers and streams, rather than reliance upon surrogate measures such as chemical concentration data.

At the same time the Health Department was increasing its commitment to biological monitoring, it reduced the number of ambient chemical monitoring sites from the 61 operated in 1993 to 27 sites in 1994. The 27 sites established in 1994 were a combination of sites established as part of the historic monitoring network, plus some new sites. Where practical, sites were co-located with USGS flow gauging stations, thereby facilitating the analysis of chemical data with stream hydrologic data. All of these sites were established as basin or sub-basin integrator sites, where the chemical character measured at each site reflects water quality effects in the entire watershed. It is the department’s intention to maintain these as long-term monitoring sites for the purpose of assessing water quality trends and to describe the general chemical character of the state’s major river basins.

With a grant from the EPA Clean Lakes Program, the Health Department initiated what is termed the Lake Water Quality Assessment (LWQA) Project in 1991. The objective of the assessment project is to describe the general physical and chemical condition of the state’s lakes and reservoirs. To date, data collection and analysis and reports have been completed on 87 lakes and reservoirs. Each lake assessment report provides a description of the waterbody, general water quality characteristics, plant and phytoplankton diversity, trophic status estimates, and watershed condition.

Seventy-one percent (8460 miles) of the 11,928 mile of rivers and streams assessed for this report fully support the beneficial use designated as aquatic life. Of the streams assessed as fully supporting aquatic life use, 87 percent (7364 miles) are considered threatened. In other words, if water quality trends continue, these streams may not fully support their use for aquatic life in the future. The remaining 29 percent of rivers and streams assessed for this report were either partially supporting or did not support aquatic life use.

Nonpoint Source (NPS) pollution (e.g., nutrient loading, siltation of the streambed, and stream habitat loss or degradation) was the primary cause of aquatic life use impairment. Other forms of pollution causing impairment are trace element contamination, flow alteration, and organic enrichment. Organic enrichment creates conditions in the stream which cause dissolved oxygen (DO) to be depleted. The primary sources of these pollutants are cropland erosion and runoff, confined animal feeding operations, wetland drainage, and poor grazing management. Poor grazing management includes riparian grazing and season-long grazing. Other pollutant sources linked to aquatic life use impairment are point source discharges, urban runoff, and stream channel/flow alteration (e.g., upstream impoundments, low-head dams, channelization, flow regulation and diversion, riparian vegetation removal).

Recreation use was assessed on 9000 miles of rivers and streams in the state. Recreation use was fully supporting, fully supporting but threatened, partially supporting, and not supporting on 1440 miles, 4565 miles, 2781 miles, and 214 miles, respectively. Pathogens as represented by fecal coliform bacteria data collected from monitoring stations across the state were the primary cause of recreation use attainment. The primary sources of fecal coliform bacteria contamination in the state are confined animal feeding operations and riparian area grazing.

Drinking water supply use is classified for 5320 miles of rivers and streams in the state. Of the 687 miles assessed for this report, only 34.4 miles (5 percent) were assessed as partially supporting their use for drinking water supply. The primary cause of use impairment are taste and odor problems.

A total of 5600 miles of rivers and streams were identified as capable of supporting a sport fishery from which fish could be used for consumption. Four-hundred-sixty miles of rivers and streams have been monitored for methyl-mercury in fish, resulting in consumption advisories. These advisories form the basis for fish consumption use impairment in the state. While there are many potential sources of methyl-mercury (anthropogenic and natural), there have been no specific sources identified for the mercury present in North Dakota fish to date.

A total of 116 lakes and reservoirs (42 natural lakes and 74 reservoirs), representing 631,228 surface acres, were assessed for this report. Fourteen lakes and reservoirs, representing 140,442 acres, were assessed as fully supporting aquatic life use. Fifty-one lakes and reservoirs, representing 460,177 acres, are considered threatened. Fifty lakes and reservoirs, totaling 24,609 surface acres, were assessed as partially supporting aquatic life use. One of the primary causes of aquatic life impairment to the state's lakes and reservoirs is low DO in the water column. Low DO in lakes can occur in summer (referred to as summer kills), but usually occurs in the winter under ice cover conditions when senescent plants and algae decompose, consuming available oxygen. Pollutants which stimulate the production of organic matter, such as plants and algae, can also cause aquatic life impairment. Two such secondary pollutant causes are excessive nutrient loading and siltation.

Major sources of nutrient loading to the state's lakes and reservoirs are erosion and runoff from cropland, runoff from concentrated livestock feeding and wintering operations, and wetland drainage. Wetland drainage, channelization, and ditching increase the runoff and delivery rates to lakes and reservoirs, in effect, increasing the size of a lake's watershed. Nutrients, sediment, and organic matter, which would be retained in wetlands under normal conditions, become part of the lake's external budget. Other sources of nutrient loading which affect lakes in the state are point source discharges from municipal wastewater treatment facilities, urban/stormwater runoff, and shoreline development.

Recreation use (e.g., swimming, waterskiing, boating, sailing, sunbathing) was assessed for 625,591 lake and reservoir acres in the state. Of this total, 51 lakes, representing 99,474 acres, were assessed as partially supporting use for recreation. The primary cause of use impairment is excessive nutrient loading, which results in nuisance algal blooms and noxious aquatic plant

growth. Sources of nutrients causing algal blooms and weed growth were described in the previous section on aquatic life use. Fifty lakes totaling 391,010 acres were assessed as threatened. Nutrient loading is also linked to the negative water quality trends these lakes are experiencing. If left unchecked, these lakes will degrade to the point where frequent algal blooms and/or excessive weed growth will negatively affect recreation.

Thirty-three lakes and reservoirs, totaling 494,389 acres, were considered partially supporting fish consumption use. The remaining 182 lakes and reservoirs which support a sport fishery were not assessed for this report. The 33 lakes and reservoirs assessed as partially supporting fish consumption use were so designated because each one has a fish consumption advisory. The advisory for each lake limits the consumption of fish due to methyl-mercury. Sources of methyl-mercury in fish remain largely unknown. Potential sources of mercury include natural sources, atmospheric deposition, and runoff from cropland containing grain that was treated with a mercury-based fungicide. (Note: The use of these fungicides is now prohibited.)

Four reservoirs (Lake Sakakawea, Homme Dam, Bisbee Dam, and Mt. Carmel Reservoir) are currently used either directly or indirectly as municipal drinking water supplies, while two others (Patterson Lake and Renwick Dam) serve as back-up water supplies in the event the primary water supplies should fail.

Mt. Carmel Reservoir, Lake Sakakawea, and Homme Dam were assessed as fully supporting use for drinking water supply. The remaining reservoirs were assessed as partially supporting use for drinking water supply. The primary causes of partial use support are frequent algal blooms stimulated by excessive nutrient loading and siltation. Algal blooms affect the taste and odor of a drinking water supply and increase treatment costs. Siltation decreases reservoir volume, thereby reducing reservoir storage capacity as a drinking water supply. Agricultural runoff from cropland and concentrated animal feeding operations are the primary sources of nutrients and sediment to reservoirs partially supporting drinking water supply use. Poor grazing management of pasture land, range land, and along riparian areas is also a significant source of sediment to water supply lakes and reservoirs. In particular, riparian area grazing destroys streambank vegetation, creating bank erosion which can be a significant source of sediment to lake and reservoirs.

Wetlands have long been regarded as nuisance areas or wastelands which only serve to impede agriculture, urban, or transportation development. Only recently have the ecological and social functions and values of wetlands been realized. It is now scientifically proven that wetlands are important for the storage of flood waters, providing fish and wildlife habitat, recharging ground water, and retaining and cycling chemical pollutants and particulates. It is estimated that 2.5 million acres of wetlands remain of the approximately 4.9 million acres of wetlands which covered North Dakota prior to development. This represents a 49 percent reduction in wetlands.

Wetland integrity should be thought of in terms of whether a wetland performs a set of functions or uses which would be expected for natural or "reference" wetlands of a similar class or type. Therefore, whenever a wetland's function is diminished, it can be said that wetland integrity is diminished. Hydrologic manipulation (e.g., drainage, wetland consolidation, channelization, and

filling) continues to be the greatest impact on the integrity of the state's wetland resource. While not as dramatic, other factors such as chemical contamination, nutrient loading (i.e., eutrophication), and sedimentation can also affect a wetland's function and, therefore, the chemical, physical, and biological integrity of the wetland.

Ground water in North Dakota occurs in two major rock types referred to as unconsolidated rock and bedrock (underlying the unconsolidated rock). Aquifers in the unconsolidated rock are primarily the result of glacial outwash deposits of the Quaternary Age and are called glacial drift aquifers. These deposits are typically more productive and generally yield less mineralized water than that of the underlying bedrock. At the present time, approximately 192 separate glacial drift aquifers have been identified and delineated throughout the state. Bedrock aquifers tend to be more continuous and widespread than aquifers in the unconsolidated rocks. Water from bedrock aquifers tends to be more mineralized and occurs primarily along fractures in the rock. The major bedrock aquifers include the Dakota, Pierre, and Fox Hills-Hell Creek Aquifers of the Cretaceous Age and the Fort Union Aquifer of the Tertiary Age.

It is estimated North Dakota has approximately 470 million acre-feet (MAF) of water stored throughout the various aquifer systems. Although these systems are abundant and widely dispersed, consumptive use demands, accessibility, and overall quality has limited the use of ground water for beneficial applications in some areas.

Consumption of ground water in North Dakota has historically been categorized as agricultural (e.g., irrigation or livestock watering), industrial, and domestic (private or public) use. In 1996, it was estimated that the highest consumptive use of ground water was related to agricultural irrigation. Other uses such as public water supply, industrial, domestic (private water wells), and livestock followed in decreasing consumptive use quantities.

When compared to the total quantity of ground water stored in the state's aquifers, less than 1 percent of the ground water resource is used. The majority of all water use is typically concentrated in small geographical locations. This is considered to be a function of several factors, including accessibility and water quality.

Contamination of ground water from anthropogenic sources has occurred in every county of the state. The degree to which contamination incidents are investigated or remediated is a function of the contaminant, its impact on the beneficial use of the resource, and the overall risk it poses to the public or environment. Due to funding limitations, ground water protection programs and contamination assessments are addressed on a site-by-site basis.

To determine where to spend the limited financial and human resources required to implement ground water assessment and protection activities, the Health Department's Division of Water Quality developed the Geographic Targeting System (GTS). The GTS was developed in 1992, in an effort to prioritize aquifers in order of their susceptibility to contamination. The GTS evaluation does not identify critical recharge areas or areas where special management practices must be applied. Rather, the evaluation identifies aquifer settings where an increased

contamination potential exists. Aquifers identified as having an elevated potential for ground water contamination are highlighted as requiring increased assessment and educational activities relating to ground water quality protection.

In 1992, the Health Department's Division of Water Quality initiated an ambient ground water monitoring program to determine the occurrence of 50 selected agricultural pesticides in the 50 most vulnerable aquifer systems within a 5-year period. Sample locations are determined using a selection process, which considers well construction integrity, well location, and the presence of water treatment systems. Since its initiation in 1992, approximately 760 wells in the 50 most vulnerable aquifer systems have been monitored.

The North Dakota Pollutant Discharge Elimination System (NDPDES) permit program regulates the release of wastewater and stormwater from point sources into waters of the state. All point source dischargers, both municipal and industrial, are required to obtain a permit. These permits outline technology-based and water quality-based limits for wastewater discharges.

Since 1975, approximately 400 discharge permits (25 percent industrial and 75 percent municipal) have been issued to point source dischargers of wastewater. In 1992, the NDPDES Program established permit coverage for stormwater discharges from industrial facilities in response to the addition of stormwater to the National Pollutant Discharge Elimination System. Currently, there are about 500 facilities covered under general permits for stormwater discharges.

The Health Department has an aggressive inspection and operator training program. Program staff are primarily responsible for inspecting all components of public treatment works and for conducting operator training. One of the goals of the inspection program is to conduct an inspection of each municipal treatment system at least once a year. In addition to verifying proper system operation, the inspections reaffirm to the operator the importance of proper operation in protecting the state's water resources. The inspectors also serve as primary instructors for the Health Department's wastewater operator training and certification seminars conducted during the winter and spring months. In addition to the seminars, the program provides individual training and assistance to facilities encountering treatment problems. The inspection program is largely responsible for the improvement in the quality of municipal wastewater discharges. North Dakota regulations require a certified operator for municipalities with populations of greater than 500.

The impact to waters from livestock and feeding operations continues to be an increasing concern in North Dakota. The state's livestock regulations require Health Department approval for: 1) concentrated feeding operations with over 200 animal units, 2) operations with over 100 animal units and located in a floodplain, 3) operations located where the distance to surface water is less than 2 feet per animal unit, and 4) operations that cause or are likely to cause pollution to waters of the state. The department reviews the design plans for these facilities to ensure that the waste can be adequately contained and disposed of to prevent impacts to waters of the state. If the facility is properly designed, an approval is issued.

Currently, there are over 900 livestock operations on record as having been approved by the

Health Department. Most of these operations are cattle wintering operations, hog operations, and dairy operations that farmers have as a part of their total farming operations. However, over the past few years there has been an increase in facilities that are strictly large, confined, feeding operations for turkeys, hogs, and dairy cattle. With an increase in these larger operations, the department has updated its approval process to require better management practices for the increased volume of waste. This helps to ensure operators take responsibility for proper land application of waste to minimize odors or other nuisances that may impact nearby residents.

Efforts to control NPS pollution and maintain or improve North Dakota's water resources are primarily accomplished through the North Dakota NPS Pollution Management Program. As the lead state water quality agency, the Health Department is responsible for the administration and coordination of the state's NPS Pollution Management Program. This nonregulatory program is designed to encourage and support local NPS pollution control/abatement initiatives. The Health Department, in cooperation with the NPS Task Force, provides technical assistance and financial support to local sponsors addressing NPS pollution issues within approved priority areas. Financial support, provided through Section 319 of the Clean Water Act, is available to the sponsors through a competitive grant application process.

The state's NPS program was developed through three major components, as required by Section 319 of the Clean Water Act. These components are the *NPS Pollution Assessment Report*, the *NPS Pollution Management Program Report*, and the creation of the NPS Pollution Task Force. The *NPS Pollution Assessment Report*, provided to EPA in December 1988, was written to identify the extent of NPS pollution problems in the state.

Submitted to EPA in January 1990, the *NPS Pollution Management Program Report* provides an overview of the state's program, as well as a summary of NPS pollution management goals. This report was updated in May 1992, and again in September 1993, to revise the priority waterbody list, identify new program strategies, and adopt additional best management practices (BMPs).

The NPS Pollution Task Force is comprised of representatives from several public agencies and private groups. The Task Force provides input and recommendations on local projects funded through Section 319, as well as various NPS program activities (e.g., assessment reviews, BMP reviews, etc.).

The North Dakota NPS Pollution Management Program has provided financial support to 31 projects since 1990. Of these projects, 15 are currently active, and 16 have been completed. While the size, type, and target audience of these projects may vary significantly, they all share the same basic goals. These common goals are to: 1) increase public awareness of NPS pollution, 2) reduce/prevent the delivery of NPS pollutants to waters of the state, and 3) disseminate information on effective solutions to NPS pollution.

North Dakota projects funded through Section 319 can be grouped into three separate categories. Placement of a given project into any one of these categories is simply based on the project's primary tasks and objectives. These project categories include: 1) development/assessment

phase, 2) watershed, and 3) educational.

Costs associated with municipal point source pollution control have been extensive. Capital investments in the form of additions to and construction of new wastewater treatment facilities account for the largest expenditure of funds. While the Construction Grants and State Revolving Loan Fund (SRF) programs have been the major sources of funding, many communities have upgraded wastewater treatment facilities at their own expense.

The SRF replaced the Construction Grants Program in the early 1990s. In the last two years, approximately \$11.7 million has been obligated from the SRF for the construction of wastewater system improvements. During the last ten years, over \$83.2 million has been invested in wastewater system improvements. The cumulative amount since passage of the Clean Water Act in 1972 is approximately \$272 million. In addition to the capital costs, an estimated \$5 million per year is spent operating and maintaining wastewater treatment systems.

There have been many improvements in water quality since passage of the Clean Water Act in 1972. Much remains to be done, however, if the goal of restoring and maintaining the chemical, physical, and biological integrity of the state's and nation's waters is to be achieved.

PART II. BACKGROUND

Table 1. Atlas

Topic	Value
State Population ¹	638,800.00
State Surface Area (Sq. Miles)	70,665.00
Total Miles of Rivers and Streams ²	53,989.40
Total Miles of Rivers and Streams by Stream Class ³	
Class I, IA, and II Streams	5,418.42
Class III Streams	48,570.98
Total Miles of Rivers and Streams by Basin	
Red River (including Devils Lake)	11,794.77
Souris River	3,645.00
Upper Missouri (Lake Sakakawea)	13,866.86
Lower Missouri (Lake Oahe)	21,930.12
James River	2,752.65
Border Miles of Shared Rivers and Streams ⁴	427.03
Total Number of Lakes and Reservoirs ⁵	219.00
Number of Natural Lakes	88.00
Number of Manmade Reservoirs	13.00
Total Acres of Lakes and Reservoirs	650,380.00
Acres of Natural Lakes	111,825.10
Acres of Manmade Reservoirs ⁶	538,554.90
Acres of Freshwater Wetlands ⁷	2,000,000.00

¹ Based on the 1990 Census.

² Total miles based on the U. S. EPA RF3 file.

³ Stream classes are defined in the *State Water Quality Standards* (NDDH, 1991). In general, Classes I, IA, and II streams are perennial, while Class III streams are intermittent or ephemeral.

⁴ Includes the Bois de Sioux River and the Red River of the North.

⁵ Number includes only the lakes and reservoirs which are publicly owned and are in the WBS.

⁶ Estimates based on surface acreage at full pool elevation.

⁷ Estimate provided by Dahl, T.E., *Wetlands - Losses in the United States: 1780's to 1980's*, Washington, D.C., U. S. Fish and Wildlife Service Report to Congress, 1990.

Total Waters

The Health Department currently recognizes 219 lakes and reservoirs for water quality assessment purposes. Of this total, there are 131 manmade reservoirs and 88 natural lakes. This is a change from the 121 reservoirs and 96 natural lakes entered during the 1994 reporting cycle. The difference between the 1994 and 1996 numbers is due to some minor changes in the interpretation of a reservoir versus a natural lake and the addition of two reservoirs on Pipestem Creek. All lake and reservoirs included in this assessment are considered significantly publicly owned.

Reservoirs are defined as waterbodies formed as a result of dams or dugouts constructed on natural or manmade drainages. Natural lakes are waterbodies having natural lake basins. A natural lake can be enhanced with outlet control structures, diversions, or dredging. Based on the state's WBS tracking system, the 131 reservoirs have an areal surface of 538,544 acres. Reservoirs comprise about 83 percent of North Dakota's total lake/reservoir surface acres. Of these, 480,731 acres or 74 percent of the state's entire lake and reservoir acres are contained within the two mainstem Missouri River reservoirs (Lake Sakakawea and Lake Oahe). The remaining 129 reservoirs share 57,824 acres, with an average surface area of 448 acres.

The 89 natural lakes in North Dakota cover 111,825 acres with approximately 74,500 acres or 67 percent attributed to Devils Lake. The remaining 88 lakes average 424 acres with the majority being smaller than 200 acres.

There are 53,989 miles of rivers and streams in the state. When compared to the 1994 report, this reflects an increase of over 42,000 miles. This increase in total miles of rivers and streams is due to the method by which the Health Department currently recognizes and measures rivers and streams.

For this report, estimates of river stream miles in the state are based on EPA's River Reach File Version 3.0 (RF3). RF3 is derived from the USGS's 1:100,000 scale Digital Line Graph (DLG) data. The DLG data contains all hydrologic features which are found on paper maps of the same scale. Due to the detail of these maps and the resultant DLG data, total river miles increased significantly from estimates made in previous years.

In this report, the state has been divided into five basins: Red River (including Devils Lake), Souris River, Upper Missouri River (or Lake Sakakawea), Lower Missouri River (or Lake Oahe), and James River (Figure 1). The atlas provided in Table 1 provides a basin-by-basin estimate of total river and stream miles.

Figure 1. Five Major Hydrologic Basins in North Dakota

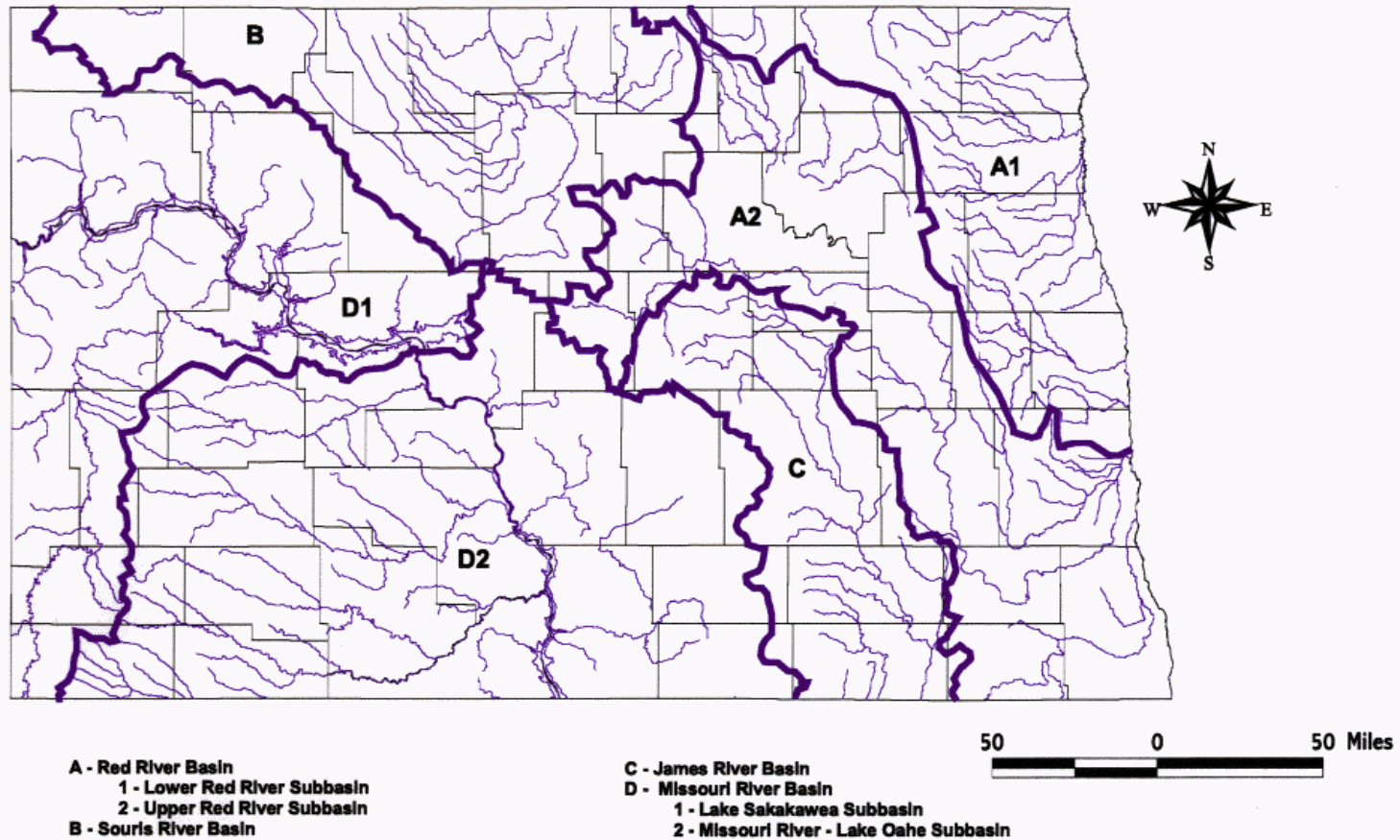


Figure 1. Major Hydrologic Basins in North Dakota

Water Pollution Control Program

Chapter 1. Water Quality Standards Program

The State of North Dakota periodically updates the standards of water quality. The standards delineate the policy of the state which is to protect, maintain, and improve the quality of water for use as public and private water supplies; for propagation of wildlife, fish, and aquatic life; and for domestic, agricultural, industrial, recreational, and other legitimate beneficial uses.

The state classifies its water into five categories. The assignment of a waterbody into a particular classification is based on the water quality of record (1967), existing uses at that time, hydrology, and natural background factors.

The standards identify specific numeric criteria for chemical, biological, and physical parameters. The specific numeric standard assigned to each parameter ensures protection of the beneficial uses for that classification. The standards also contain general conditions applicable to all waters of the state. These general conditions contain provisions not specifically addressed in numeric criteria. These conditions add an extra level of protection for water quality.

The beneficial uses of wetlands are currently under consideration. Wetlands are waters of the state and, therefore, protected by general conditions.

The state is also in the process of developing "biological criteria." These criteria will define ecological conditions in state waters and set goals for their attainment.

Chapter 2. Point Source Control Program

The NDPDES permit program regulates the release of wastewater and stormwater from point sources into waters of the state. All point source dischargers, both municipal and industrial, are required to obtain an permit. These permits outline technology-based and water quality-based limits for wastewater discharges.

Since 1975, approximately 400 discharge permits (25 percent industrial and 75 percent municipal) have been issued to point source dischargers of wastewater. In 1992, the NDPDES Program established permit coverage for stormwater discharges from industrial facilities in response to the addition of stormwater to the National Pollutant Discharge Elimination System. Currently, there are about 500 facilities covered under general permits for stormwater discharges.

Facilities covered under a general permit for stormwater discharges must implement pollution prevention plans to improve the quality of stormwater discharges. In addition, periodic sampling of stormwater discharges is required. This sampling information will enable the Health Department to evaluate the effectiveness of the pollution prevention practices.

In addition to general permits, the department has been working with the major municipalities on development and implementation of a guidance document for snow disposal/storage.

Wastewater impoundments are the most widely used and accepted manner of wastewater treatment and storage in North Dakota. The primary reasons for their acceptance are their low operation and maintenance costs and the availability of land in the state. A facility that receives permission to discharge wastewater to a surface waterbody is required to monitor and report information on the quantity and quality of the discharge. The Health Department reviews this information and maintains it in a computer database. The overall quality of wastewater is commonly indicated by 5-day biochemical oxygen demand (BOD-5) and total suspended solids (TSS). Typically, high concentrations of BOD and TSS indicate poor treatment system performance and present an environmental concern. Figures 2 and 3 show a decrease in the mean annual discharge concentrations of BOD-5 and TSS, respectively, for the 13-year period from 1981 to 1995. There is a slight increase starting in 1993--the result of extremely wet conditions during the last two years. In addition, the wastewater from many of the state's permitted facilities is discharged over land or through ditches before it reaches a waterbody. In such cases, it is likely the reported concentrations for BOD-5 and TSS are further reduced prior to entering the waterbody.

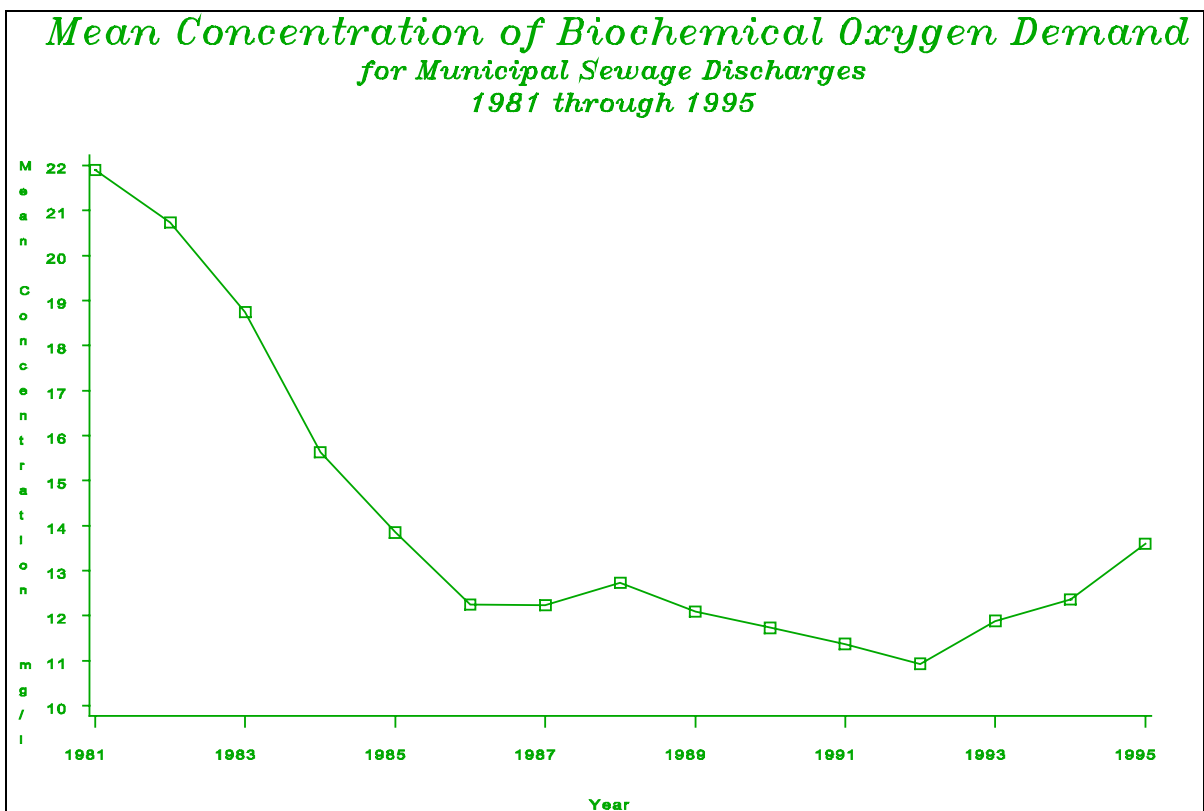


Figure 2

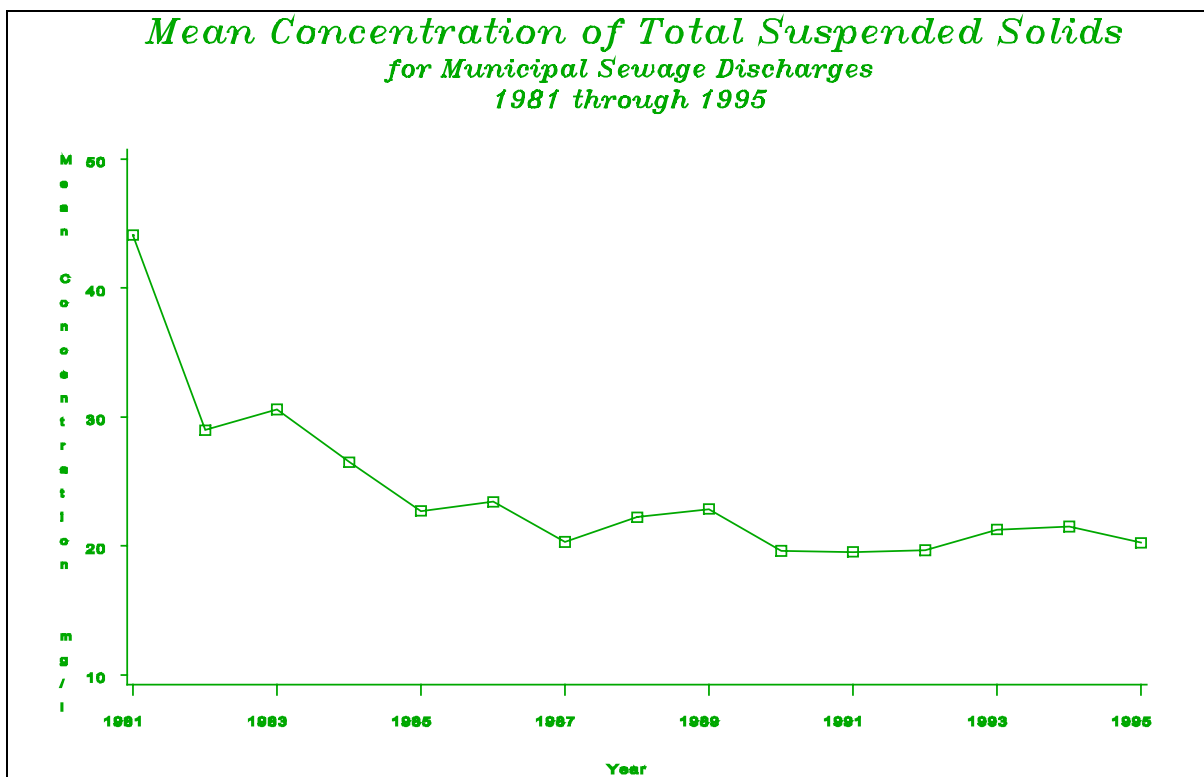


Figure 3

The control of toxic pollutants in wastewater discharges is an important concern, particularly for the larger cities and industries in the state. The primary means of controlling toxic pollutants in wastewater is through the industrial pretreatment program administered in North Dakota by the EPA. This program regulates the individual industries using municipal sewer systems. The department has been exploring the option of taking over the pretreatment program from EPA Region VIII. A draft program package will be developed and submitted for comments.

In addition to the monitoring of conventional wastewater pollutants, Whole Effluent Toxicity (WET) testing of the treated wastewater discharges from all major permittees (including both municipalities and industries) is required on a regular basis. Should the results from these tests indicate the effluent is toxic to aquatic organisms, a toxicity identification evaluation (TIE) may be required.

In an effort to determine the city of Mandan's sources of toxicity, the Health Department and the city participated in a Mirotox study in February and March of 1994. Due to the bacteria's sensitivity to pH fluxes, the results indicated that some industries may have a pH problem. However, the study did not reveal any blatant sources of toxicity that may inhibit the treatment process at the wastewater plant.

The Health Department has an aggressive inspection and operator training program. Program staff are primarily responsible for inspecting all components of public treatment works and for conducting operator training. One of the goals of the inspection program is to conduct an inspection of each municipal treatment system at least once a year. In addition to verifying proper system operation, the inspections reaffirm to the operator the importance of proper operation in protecting the state's water resources. The inspectors also serve as primary instructors for the Health Department's wastewater operator training and certification seminars conducted during the winter and spring months. In addition to the seminars, the program provides individual training and assistance to facilities encountering treatment problems. The inspection program is largely responsible for the improvement in the quality of municipal wastewater discharges. North Dakota regulations require a certified operator for municipalities with populations of greater than 500.

Several cities and industries have selected biological treatment methods to improve their wastewater treatment systems. The biological treatment unit at the Amoco Refinery in Mandan is providing consistent, advanced treatment of wastewater. On average, the effluent contains less than 40 percent of the loading allowed by the NDPDES permit for limited pollutants.

Devils Lake's "Lemna" system was specifically designed to remove phosphorus from the wastewater. Although the system generally provides an advanced level of nutrient removal, recent regional flooding has taxed the system beyond its design capabilities. An interim phosphorus limit has been instituted to compensate for the adverse operational conditions which currently prevail.

In 1992, artificial wetland treatment additions at the city of Minot and American Crystal Sugar at Hillsboro became fully operational. A similar system at American Crystal Sugar in Drayton was

completed in 1994. With the wetland systems, these facilities have been able to maintain low concentrations of ammonia in the final effluent during the summer discharge months. This is particularly beneficial to Minot's facility, which discharges to the Souris River. The Souris River has a history of poor river quality and low or no flow conditions during the summer season. With the addition of the wetland, Minot is capable of continuously discharging a quality effluent during the spring and summer, thereby adding to the river flow and enhancing aesthetic river qualities.

American Crystal Sugar has chosen to use wetlands to improve wastewater quality and to expand the capacity of its wastewater systems. The effluent consistently surpasses the federal effluent criteria for suspended solids and oxygen demand by a significant degree. Additionally, these systems serve as full-scale models for other facilities exploring artificial wetlands as a cost-effective means of improving wastewater systems.

A major expansion and upgrade at the city of Fargo's wastewater treatment plant was completed in the fall of 1995. The city went from an intermittent to a continuous discharger. The upgrade increased the plant's hydraulic capacity from 9 million gallons a day (MGD) to 15 MGD. The upgrade consisted of the following: a new pretreatment/odor control facility, two new primary clarifiers, new media and increased size of the three trickling filters, two new nitrification filters, two new final clarifiers, a new disinfection facility, and covers for all clarifiers and filters. Fargo still maintains its six, 90-acre wastewater stabilization ponds which can be used to contain the effluent from the mechanical plant should its quality threaten to exceed the state's water quality standards for the Red River. The upgrade and the capability of using the ponds provide greater flexibility in managing discharges to the Red River.

The impact to waters from livestock and feeding operations continues to be an increasing concern in North Dakota. The state's livestock regulations require Health Department approval for: 1) concentrated feeding operations with over 200 animal units, 2) operations with over 100 animal units and located in a floodplain, 3) operations located where the distance to surface water is less than 2 feet per animal unit, and 4) operations that cause or are likely to cause pollution to waters of the state. The department reviews the design plans for these facilities to ensure that the waste can be adequately contained and disposed of to prevent impacts to waters of the state. If the facility is properly designed, an approval is issued.

Currently, there are over 900 livestock operations on record as having been approved by the Health Department. Most of these operations are cattle wintering operations, hog operations, and dairy operations that farmers have as a part of their total farming operations. However, over the past few years there has been an increase in facilities that are strictly large, confined, feeding operations for turkeys, hogs, and dairy cattle. With an increase in these larger operations, the department has updated its approval process to require better management practices for the increased volume of waste that is handled. This helps to ensure operators take responsibility for proper land application of waste to minimize odors or other nuisances that may impact nearby residents.

The Health Department is continuing to provide educational materials to livestock producers and the public on the impacts livestock waste has on waters of the state. The department has

participated in numerous presentations to producer groups throughout the state on livestock waste pollution. In addition, the Health Department is continuing to work closely with the Natural Resources Conservation Service (NRCS) and local health units on livestock waste systems. The department is also working with the North Dakota State University Agriculture Extension Service and a number of livestock producer groups in the state such as the North Dakota Pork Producers and the North Dakota Turkey Federation. Many of these groups are taking steps to educate their members on pollution concerns and state regulations. The department is taking steps to maintain better contact with approved livestock operations by mailing information on livestock waste management and state regulations.

The Health Department works closely with local zoning boards and county commissions to help them recognize sensitive areas where livestock operations could cause problems and to encourage them to limit the expansion of operations in these areas. The Health Department works through its NPS Pollution Management Program and Ground Water Program during the review process for proposed livestock waste control systems.

The department issued a permit to ProGold LCC in July 1995 for a 200,000-bushel-per-day, corn wet milling facility located near Wahpeton. The discharge will consist primarily of treated wastewater from the processes involved with the wet milling of corn to produce and refine high fructose corn syrup and related feed co-products. The discharge will be to the Red River, which is a Class I stream in the state. The review and issuance of this permit were very time-consuming and controversial. Both a public meeting and a formal hearing were held prior to writing the final permit language. Canadian agencies, EPA Region VIII, several state and federal agencies in North Dakota and Minnesota, and numerous municipalities along the Red River provided comments on the draft permit. The final permit reflected all comments and concerns, resulting in a common-sense approach which maintained water quality standards in both states. Strong NDPDES, operator training and facility inspection, and feedlot programs, combined with wastewater treatment facility upgrades, have all contributed to the improvement of the quality of wastewater discharges to the waters of North Dakota.

Chapter 3. NPS Pollution Control Program

Background

Surface water and ground water are two of North Dakota's most valuable natural resources. Water quality is affected by both natural and cultural, point source and NPS pollution, with NPS pollution being the major factor affecting surface water quality. Ground water quality has remained relatively unaffected by major sources of pollution. However, some aquifers have experienced minor water quality impairments (see Part IV. Ground Water Assessment).

All rivers, streams, reservoirs, and lakes assessed within the state are impacted to some degree by NPS pollution. Impacts can generally be attributed to agricultural activities. Ground water impacts have resulted from the improper use of agricultural chemicals, leaking underground petroleum storage tanks and pipelines, wastewater impoundments, oil and gas exploration activities, septic systems, and improperly located and maintained solid waste disposal sites.

Efforts to control NPS pollution and maintain or improve North Dakota's water resources are primarily accomplished through the North Dakota NPS Pollution Management Program. The state's NPS program was developed through three major components, as required by Section 319 of the Clean Water Act. These components are the *NPS Pollution Assessment Report*, the *NPS Pollution Management Program Report*, and the creation of the NPS Pollution Task Force.

The *NPS Pollution Assessment Report*, provided to EPA in December 1988, was written to identify the extent of NPS pollution problems in the state. Submitted to EPA in January 1990, the *NPS Pollution Management Program Report* provides an overview of the state's program, as well as a summary of NPS pollution management goals. This report was updated in May 1992, and again in September 1993, to revise the priority waterbody list, identify new program strategies, and adopt additional BMPs.

The NPS Pollution Task Force is comprised of representatives from several public agencies and private groups. The Task Force provides input and recommendations on local projects funded through Section 319, as well as various NPS program activities (e.g., assessment reviews, BMP reviews, etc.). The Task Force also serves as the U. S. Department of Agriculture (USDA) - NRCS Water Quality Task Force Committee. Agencies and groups represented on the Task Force are listed in Table 2.

Table 2. NPS Pollution Task Force Member Agencies and Groups

EPA
Farm Service Agency
McKenzie County Grazing Association
NRCS
North Dakota Association of Soil Conservation Districts
North Dakota Association of Resource Conservation and Development Councils
North Dakota County Commissioners
North Dakota Department of Agriculture
North Dakota Farmers Union
North Dakota Forest Service
North Dakota Game and Fish Department
North Dakota Grain Growers Association
North Dakota Parks and Recreation Department
North Dakota Pork Producers
North Dakota Soil Conservation Committee
North Dakota Department of Health
North Dakota Farm Bureau
North Dakota Geological Survey
North Dakota State University Extension Service
North Dakota State Water Commission
North Dakota Water Resource Districts Association
North Dakota Wildlife Federation
Rural Economic and Community Development
Rural Water Users Association
The International Coalition
Three Affiliated Tribes
University of North Dakota Energy & Environmental Research Center
U. S. Department of Agriculture - Agriculture Research Service
U. S. Bureau of Land Management
U. S. Bureau of Reclamation
U. S. Fish and Wildlife Service
U. S. Forest Service
U. S. Geological Survey

As the lead state water quality agency, the Health Department is responsible for the administration and coordination of the state's NPS Pollution Management Program. This nonregulatory program is designed to encourage and support local NPS pollution control/abatement initiatives. The Health Department, in cooperation with the NPS Task Force, provides technical assistance and financial support to local sponsors addressing NPS pollution issues within approved priority areas. Financial support, provided through Section 319 of the Clean Water Act, is available to the sponsors through a competitive grant application process.

During this process, project work plans must be reviewed and approved by both the Task Force and EPA before Section 319 funds are allocated for the project. Following approval of the project, the Section 319 funds are administered by the Health Department and appropriated to the local sponsoring entities through annual contractual agreements. These funds are generally used to employ staff, implement BMPs, conduct information and education (I&E) activities, document water quality improvements, assess NPS pollution impacts, or a combination of the above.

Technical assistance is provided throughout the review process, as well as during work plan development. Daily management and implementation of the locally sponsored projects is usually accomplished through such entities as the soil conservation district (SCD) and/or the water resource district (WRD). Table 3 lists the various organizations and groups which have sponsored Section 319 projects in North Dakota.

Table 3. Local and State Agencies or Groups Which Have Sponsored or Co-Sponsored NPS Pollution Control Projects

Soil Conservation Districts
Water Resource Districts
Resource Conservation and Development Councils
Extension Service
Universities
Grazing Associations
County Commissions
City Councils
State Water Commission
North Dakota Department of Agriculture

In addition to the Section 319 NPS Pollution Management Program administered by the Health Department, there are many other state and federal programs which either directly or indirectly address NPS pollution. Table 4 summarizes these programs.

Table 4. Federal, State, and Local Programs Which Directly or Indirectly Control NPS Pollution

Program	Local	<u>Administering Agency</u>		Program Area	Water Quality Effectiveness
		State	Federal		
Ag. Conservation Program*			FSA ¹	Statewide	Partially
Resource Conservation & Development Fund*	Local unit		FSA	Statewide	Partially
Watershed Protection Project*			NRCS ²	Local	Locally
Water Quality Incentive Program*			FSA	Local	Partially
Great Plains Conservation Program*			NRCS	Regional	Locally
Food Security Act of 1985, 1990					
Conservation Reserve Program*	SCDs ³		NRCS	Statewide	Partially
Swampbuster Act*	SCDs		FSA NRCS	Statewide	Partially
401 Water Quality Certification*		Health Dept.	COE ⁴	Local	Fully
Waterbank Program*			FSA	Local	Fully

Table 4. (cont.) Federal, State, and Local Programs Which Directly or Indirectly Control NPS Pollution

Program	Local	<u>Administering Agency</u>		Program Area	Water Quality Effectiveness
		State	Federal		
Governor's Discretionary Funds*		Health Dept.	EPA	Statewide	Fully
Revolving Loan Fund*					
603(2)(C)		Health Dept.	EPA	Statewide	Partially
604(b) Title VI		Health Dept.	EPA	Statewide	Partially
205(G)*		Health Dept.	EPA	Statewide	Partially
106*		Health Dept.	EPA	Statewide	Partially
Interest - Game and Fish Reserve Funds		Game & Fish		Local	Locally
Pesticide Applicator		Ag. Dept.		Statewide	Partially
Chemigation Program		Ag. Dept.		Statewide	Partially

Table 4 (cont.). Federal, State, and Local Programs Which Directly or Indirectly Control NPS Pollution

Program	<u>Administering Agency</u>		Federal	Program Area	Water Quality Effectiveness
	Local	State			
No Net Wetland Loss		Water Commission		Statewide	Partially
Land and Water Conservation Fund		Parks and Recreation Dept.		Statewide	Partially
Water Education for Teachers		Water Commission		Statewide	Partially
Prevention/Reduction of Contamination from Ag. Chemicals and Practices		Extension Service		Statewide	Fully
Improving Water Quality for Human and Livestock Consumption		Extension Service		Statewide	Fully
Soil and Water Conservation		Extension Service		Statewide	Partially

* Federal financial assistance and development programs

¹ Farm Service Agency

² Natural Resources Conservation Service

³ Soil Conservation Districts

⁴ U. S. Army Corp of Engineers

Summary of Section 319 Projects

The North Dakota NPS Pollution Management Program has provided financial support to 31 projects since 1990. Of these projects, 15 are currently active, and 16 have been completed. While the size, type, and target audience of these projects may vary significantly, they all share the same basic goals. These common goals are to: 1) increase public awareness of NPS pollution, 2) reduce/prevent the delivery of NPS pollutants to waters of the state, and 3) disseminate information on effective solutions to NPS pollution.

To meet these goals, project sponsors use demonstrations, educational programs, etc. to familiarize the public with the types of NPS pollution impacts in the state or project area, as well as the various methods available for NPS pollution control. In conjunction with the educational activities, many of the projects, particularly the watershed projects, also provide financial and technical assistance to promote the implementation of BMPs to reduce NPS pollution. Ultimately, the success of these projects is dependent on the sponsors' ability to thoroughly educate the public on potential NPS pollution impacts. Chances for success are also enhanced when sponsors demonstrate that NPS pollution control and water quality improvements can profitably co-exist with agribusiness.

North Dakota projects funded through Section 319 can be grouped into three separate categories. Placement of a given project into any one of these categories is simply based on the project's primary tasks and objectives. These project categories include: 1) development/assessment phase, 2) watershed, and 3) educational. The following paragraphs briefly describe each project type and summarize a specific project from each category. Table 5 lists all the active and completed projects funded through the state NPS Pollution Management Program.

*** Development/Assessment Phase Projects ***

Given the competitive nature of the Section 319 funding process and the limited financial resources of state and local entities, the Health Department and NPS Task Force have recognized the need to better define NPS pollution impacts, as well as cost-effective solutions, within priority watersheds. To accomplish this, the NPS program has provided financial support to several development/assessment projects.

The primary purposes of these types of projects are to 1) identify beneficial use impairments or threats and 2) determine the extent to which those threats or impairments are due to NPS pollution. The development/assessment phase projects are generally one to two years in length. Scheduled work activities are largely dedicated to water quality and land use data collection. In conjunction with the data collection efforts, project sponsors may also implement a limited number of I&E activities to strengthen public awareness and support for future NPS pollution control efforts.

Table 5. State and Locally Sponsored NPS Pollution Control Projects

Project	Project Type	Waterbody Type	NPS Category	Section 319 Allocation	Status
Bowman-Haley Watershed	Watershed	Lake/Stream	Agriculture	\$725,600	Ongoing
Logging Camp Ranch Demonstration	Education	River/Stream	Agriculture	\$ 19,447	Complete
Barnes Co. Abandoned Well Sealing Demonstration	Education	Ground Water	Agriculture	\$ 14,056	Complete
Barnes Co. ECO-ED	Education	All Types	Crosscuts Categories	\$ 51,144	Ongoing
Fordville Aquifer Study	Watershed	Ground Water	Agriculture	\$ 21,086	Complete
Sheyenne River Improvement	Watershed	River	Agriculture	\$ 38,017	Complete
Waterbank Demonstration	Education	Wetlands	Agriculture	\$ 46,500	Complete
Zero Tillage Production Manual	Education	All Types	Agriculture	\$ 48,502	Complete
Low Energy Precision Application (LEPA)	Education	All Types	Agriculture	\$ 18,008	Complete
Area IV Abandoned Well Sealing Demonstration	Education	Ground Water	Agriculture	\$ 6,684	Complete
CRP Grazing and Haying Demonstration	Education	All Types	Agriculture	\$ 28,030	Complete
Renwick, Homme, Mt. Carmel Watershed	Watershed	Lake/River/ Ground Water	Agriculture	\$538,780	Ongoing
LaMoure Co. Abandoned Well Sealing Demonstration	Education	Ground Water	Agriculture	\$ 6,701	Complete
Area II Abandoned Well Sealing Demonstration	Education	Ground Water	Agriculture	\$ 8,325	Complete
LEPA Irrigation DemonstrationBisbee-Big Coulee	Education	Ground Water	Agriculture	\$ 53,330	Ongoing
Water Education for	Watershed	Lake/Stream	Agriculture	\$244,000	Ongoing

Teachers (WET)					
Goodman Creek Watershed	Education	All Types	Crosscuts Categories	\$212,800	Ongoing
Aquifer Geographic Targeting System	Watershed	Stream	Agriculture	\$110,000	Ongoing
	Assessment	Ground water	Agriculture	\$ 7,562	Complete
Foster Co. Regional Env. Education Series (TREES)	Education	All Types	Crosscuts Categories	\$254,200	Ongoing
Ground Water Monitoring					
	Assessment	Ground Water	Agriculture/ Urban	\$287,722	Ongoing
Red River Basin Riparian Demonstration	Education	Rivers/Streams	Agriculture	\$115,498	Ongoing
Mulberry Creek Watershed	Watershed	Lake/Stream	Agriculture/ Urban	\$127,937	Ongoing
Riparian Systems Workshop	Education	River/Streams	Crosscuts Categories	\$ 13,011	Complete
Upper Sheyenne Watershed - Phase I Development Project	Development	Lake/River	Agriculture	\$ 30,110	Complete
Hay Creek Water Quality Improvement	Development	Stream	Agriculture/ Urban	\$ 27,130	Complete
Pipestem Creek Watershed					
Lake LaMoure Water Quality Assessment Project	Watershed	Lake/Stream	Agriculture	\$411,650	Ongoing
	Development	Lake/Stream	Agriculture	\$ 6,256	Complete
Sheyenne River Monitoring (Barnes County)	Development	River	Agriculture/ Urban	\$ 11,328	Ongoing
Beaver Creek Watershed					
	Development	Lake/Stream	Agriculture/ Urban	\$ 58,861	Ongoing
Patterson Lake Watershed	Development	Lake/Stream	Agriculture	\$ 52,875	Ongoing

North Dakota has supported six development phase projects since 1994. Three of these projects were completed in 1995, and the others are scheduled for completion in 1996 and 1997. All of these projects have been implemented to more clearly define current NPS pollution impacts within the project areas. Data collected within the project areas will be used to develop comprehensive

watershed management plans.

Lake LaMoure Water Quality Assessment Project

Lake LaMoure is located on Cottonwood Creek, south of the city of LaMoure in LaMoure County, North Dakota. The reservoir, constructed in 1973, has a surface area of 495 acres and a maximum depth of 36.5 feet. The lake was created to provide water-based recreation in an area with few natural lakes.

The lake's watershed begins approximately 35 miles northwest of LaMoure near the town of Jud and ends about 5 miles south of LaMoure. The watershed has a surface area of 107,000 acres. Land use in the watershed is about 76 percent cultivated. The remaining acreage is in hay land, range land, pasture, conservation reserve program (CRP), or low density urban developments or farmsteads. Approximately 70 livestock concentration areas are located within the watershed.

In 1995, the LaMoure County SCD implemented one of North Dakota's first development phase projects. The Lake LaMoure Water Quality Assessment Project was initiated to define the relationship between land uses in the watershed and water quality in the lake. Project objectives focused on: 1) determining the amount of sediment and nutrients entering the lake, and 2) identifying potential pollutant sources in the watershed.

During the 1995 sampling season, SCD technicians collected approximately 130 water quality samples from five monitoring sites within the project area. One site was located over Lake LaMoure's deepest area, two sites at the lake's inlet and outlet, and the remaining two sites were in major sub-watersheds of Cottonwood Creek. Samples collected at the creek sites were analyzed for nitrate/nitrite as N, total Kjeldahl nitrogen as N, ammonia as N, total phosphorus as P, fecal coliform bacteria, and TSS. The in-lake samples were analyzed for the same water quality parameters as were the creek samples, with the exception of fecal coliform bacteria. Additional water quality variables monitored at the in-lake site included temperature, DO, secchi disk transparency, and chlorophyll-a.

In addition to water quality data, stream flow measurements were also taken at the lake's outlet and at all three creek sites upstream from the lake. Using both stream flow and water quality data, nutrient and sediment inputs were calculated for three different sections of the watershed and Lake LaMoure. Additionally, Lake LaMoure's water and nutrient budgets (inputs minus outputs) and biological response were also modeled.

As part of the Lake LaMoure Water Quality Assessment Project, land use data was also collected for the watershed. Watershed data was collected beginning at Lake LaMoure and extending upstream to Cottonwood Creek's headwaters near the town of Jud.

Since it was not feasible to assess the entire 107,000-acre watershed, a systematic random sampling method was employed. This systematic regime sampled every eighth 40-acre unit along three transects traversing the entire length of the watershed. Each transect route was within one of three sub-watersheds that also received discrete water quality and quantity monitoring. Within the three sub-watersheds, a total of 104 40-acre units were identified for data collection. These

sample units were surveyed twice in 1995. The first survey was performed prior to spring planting in April, and the second was conducted after seeding in May and June.

Information collected during the surveys focused on the assessment of general cropland and range/pasture land conditions. Seven land use factors were documented for each cropland sample unit. These included: 1) rainfall, 2) slope, 3) slope length, 4) soil type, 5) percent residue after spring seeding, 6) previous and new crop, and 7) tillage practices. Using this information, cropland soil losses were calculated with the Universal Soil Loss Equation (USLE) for each sub-watershed and the entire watershed. The sample units with range and/or pasture lands were assessed as either good, fair, or poor. This rating was based on factors such as the condition of the grass stand, evidence of erosion, and presence or absence of invader species. Additional land use information included: 1) presence/condition of windbreaks, 2) active sheet or rill erosion, 3) nonagricultural activities, 4) erosion control, and 5) presence of livestock wintering areas.

Three principal conclusions were drawn from the land use and water quality data: 1) the type of land use and the amount of soil conservation management employed is the most significant factor influencing the amount and type of NPS pollution being discharged to Cottonwood Creek and, ultimately, to Lake LaMoure; 2) the current amount of NPS pollution is degrading Cottonwood Creek and Lake LaMoure through sedimentation and eutrophication; and 3) the water quality degradation can be slowed or perhaps reversed by improving land management and initiating in-lake management or restoration measures.

Since the completion of the 1995 assessment, the LaMoure County SCD has developed a long-range plan to improve the recreational use and biological integrity of Lake LaMoure and Cottonwood Creek. This plan will be initiated in several phases, with the first phase addressing the most critical areas. The primary objectives for Phase I are to: 1) improve inflow water quality by reducing in-stream phosphorus concentrations by 50 percent; 2) document water quality trends and land use changes; 3) reduce in-lake sources of nutrients; and 4) increase the general public's understanding of the impacts of and solutions to NPS pollution.

*** Educational Projects ***

Educational projects are those designed to disseminate information on NPS pollution issues. These projects can be one to five years in length and may focus on a variety of local and statewide NPS pollution concerns. Educational tools typically used by project sponsors include brochures, all media (TV, radio, newspaper, etc.), workshops, tours, and demonstrations. The common goal of all educational projects is to increase public awareness of the impacts of NPS pollution and possible solutions. As a secondary benefit, many of the educational projects help build public support for future NPS pollution control activities by increasing local residents' understanding of proposed corrective measures.

All educational projects funded through the NPS Pollution Management Program are included in the *NPS Pollution Management Program Information/Education Strategy*. This document was

developed to establish long-range goals and objectives for the state NPS I&E program and to identify specific types of activities needed to strengthen existing NPS educational efforts. Currently, there are five active educational projects within the state. Ten were completed prior to 1995.

Project WET Water Quality/NPS Pollution Education for Teachers and Youth

“How to Think, Not What to Think.” This has been the emphasis of the North Dakota State Water Commission’s (SWC) Project WET (Water Education for Teachers) Program as it seeks to provide North Dakota teachers and youth with the information they need to make more knowledgeable decisions regarding North Dakota’s water resources and water quality/quantity management.

The SWC began to offer the WET Program to North Dakota educators, youth, and other individuals in 1984. Project WET, an interdisciplinary, supplementary water education program, promotes the awareness and appreciation of North Dakota’s water resources through the development and use of “classroom-ready” teaching aids.

Project WET currently offers a variety of educational materials and training opportunities to educators (including resource agency personnel; 4-H, scout, and religious leaders; private corporation personnel; and university/college pre-service teachers). The primary WET Program educational offerings include:

- * National and North Dakota WET curriculum and activity guides for grades K-12.
- * A water history education program.
- * Ground water education program.
- * Water pollution education program.
- * A hazardous waste materials education program.
- * Wetlands education and module program.
- * A water quality education program.
- * Summer water resource programs for teachers and students.
- * Water festival/celebration for elementary students.
- * Dark flow tube education program.
- * Facilitator training and education.
- * Rain stick and water quality equipment.
- * Various length credit and non-credit WET Program educational offerings.
- * North Dakota water resource reference and informational materials.

Project WET materials and activities address a wide range of water-related disciplines, including the natural and social sciences. Topics generally covered include atmospheric, surface, and ground water resources; water quality and quantity; and water management conservation and use. All educational materials take into consideration the various learning styles of the educators and students, and are designed to “fit” into a school’s existing curriculum. The user-friendly activities encourage critical thinking and problem-solving.

Project WET has proven to be one of the most successful educational programs available within North Dakota. Since 1992, over 1,200 educators have received materials and/or training through the WET Program. In addition, over 3,000 copies of various WET materials have been provided to North Dakota educators, as well as to out-of-state organizations. The North Dakota WET Program potentially reaches approximately 10,000 students on an annual basis.

It is estimated that about 30 percent of all North Dakota teachers have participated in a WET educational offering. Input from many of the teachers has indicated that students are showing an increased understanding and appreciation for the management of North Dakota's water resources.

*** Watershed Projects ***

The watershed projects are the most comprehensive projects currently implemented through the NPS Pollution Management Program. These projects, the most long-term in nature, are designed to address documented NPS pollution impacts within approved priority watersheds. The primary goals of the watershed projects are to reduce/prevent NPS pollution by: 1) promoting the voluntary application of BMPs, 2) disseminating information on effective solutions to NPS impacts, and 3) evaluating the project's progress and benefits. Local sponsors use Section 319 funding, USDA cost-share assistance, or both to employ staff, cost-share BMPs, conduct I&E events, and monitor water quality and land use trends. The watershed projects are generally five to ten years in length, depending on the size of the watershed and extent of NPS pollution impacts.

To provide direction for selecting future watershed projects and ensure limited funding is used efficiently, the Health Department and NPS Pollution Task Force have revised the NPS Program's waterbody prioritization process. Lakes, reservoirs, streams, rivers, and aquifers and their watersheds will be separated into one of three different categories or tiers. Placement of a particular waterbody into Tier I, II, or III will be based on the data or "evidence" available on the impairments/threats to the waterbody's beneficial uses and the extent to which those are due to NPS pollution. Waterbodies will also be prioritized within each tier.

Tier I waterbodies will include all lakes, streams, and rivers where beneficial use impairments/threats are well documented and the problems are known to be predominantly due to NPS pollution. Each Tier I waterbody will have sufficient monitoring/modeling information available to document the percent contribution from all sources of pollution within the waterbody's watershed. Tier I waterbodies and their watersheds will be eligible for Section 319 implementation phase funding.

Waterbodies in the Tier II category will include lakes, streams, and rivers where there is sufficient evidence that beneficial uses are being impaired or threatened. However, there is not sufficient information available to accurately identify the causes of these impairments/threats or to indicate whether the impacts are due wholly or partially to NPS pollution. Information regarding

beneficial use impairments of Tier II waterbodies may be based on “hard” monitoring data or “soft” data such as best professional judgment or questionnaire feedback.

Tier II waterbodies will also be further prioritized to identify specific waterbodies for project development activities. Prioritization of Tier II waterbodies will be based on criteria such as the number of impaired beneficial uses (e.g., fish kills, algal blooms, etc.) and the severity of those impairments. The development activities for Tier II waterbodies will generally last one to two years and include, at a minimum, a water quality monitoring plan and a watershed inventory. These assessment activities will be initiated to obtain sufficient information to accurately identify the causes of water quality problems and the extent to which the problems are due to NPS pollution.

Tier III waterbodies are lakes, rivers, streams, and their watersheds for which there is no information or evidence of beneficial use impairments/threats. In addition, there is no information as to the causes of NPS pollution. Due to this lack of information, Tier III waterbodies are targeted for other Health Department monitoring and assessment activities (e.g., lake water quality assessment, ambient stream monitoring, fish tissue surveillance, or volunteer monitoring). Waterbodies under this category will not be eligible for Section 319 funding.

The development of the three-tiered waterbody prioritization process is the first step toward creating a more structured system for targeting and approving future NPS pollution control projects. The next step will be to delineate the state’s waterbodies and their watersheds and assign a tier ranking. Tier III waterbodies will then be integrated into the existing programs of the Health Department or other agencies. Tier II waterbodies will be further prioritized and, based on that prioritization, targeted for project development activities. Tier I waterbodies will be eligible for the implementation of comprehensive NPS pollution control projects.

As this new waterbody prioritization process evolves, there may be a need to further rank or prioritize waterbodies within Tier I. Criteria considered for further prioritization of Tier I waterbodies may include the type and number of impaired or threatened beneficial uses, severity of NPS pollution impacts to beneficial uses, recreational value of the waterbody, waterbody/watershed size, state or national significance of the waterbody, and degree of local support for proposed project efforts.

Eight, locally sponsored, watershed projects have been funded through the NPS Pollution Management Program. These projects have similar goals and objectives and were implemented to address the impacts of NPS pollution originating on agricultural lands.

Goodman Creek Watershed

The Goodman Creek watershed is a sub-watershed of the Knife River, located in west central North Dakota. The project area encompasses approximately 59,000 acres, of which 52 percent is cropland and 45 percent is either range or pasture land. Low residue farming practices and overgrazing on a majority of these lands have resulted in increased occurrences of wind and water erosion throughout the watershed. As a result, agricultural pollutants attached to wind and waterborne sediments dissolved in runoff waters are being deposited in Goodman Creek at an accelerated rate.

The goals and objectives of this project are two-fold. The first, and most obvious, objective is to improve the water quality of Goodman Creek. This will be accomplished by promoting improved land management and installing various BMPs to reduce erosion on 60 percent of the agricultural lands within the watershed. These land treatment practices will primarily focus on crop residue management and livestock grazing within the project area.

A secondary objective of the project is to document and disseminate information on the positive impacts the watershed approach to resource management can have on water quality within a small watershed. Water quality and land treatment data compiled during this project will be used to determine the correlation between land treatment and water quality improvements. Upon completion of the project, the data will be analyzed to evaluate the impacts the project activities have had on water quality within the sub-watershed. This information will then be used to demonstrate to future project sponsors the cumulative effect sub-watershed treatments can have on water quality within the larger watersheds of North Dakota.

The Goodman Creek Watershed Project Implementation Plan was approved by EPA on June 30, 1993. Following approval from EPA, the project sponsors employed a watershed conservationist to provide one-on-one planning assistance to producers in the watershed, as well as to organize and conduct the project's monitoring and educational activities.

The educational component of the project has been designed to disseminate information to local residents about the impacts of and solutions to NPS pollution within North Dakota. Educational efforts currently being utilized by the project sponsors include all forms of the media, workshops, seminars, newsletters, direct mailings, demonstrations, and one-on-one consultations with landowners. While these activities have generally been targeted toward the adult population in the watershed, the sponsors have also recently provided project area tours for local eighth grade students. With the addition of a youth education component, the project sponsors hope to broaden all local residents' awareness of NPS pollution and its impacts on water quality.

Within the watershed, project staff have also provided on-farm financial and technical assistance to encourage development of farm unit resource management plans addressing specific NPS pollution sources. Through this planning process, the cooperating producer and project staff identify and schedule the implementation of various BMPs needed to address NPS pollution on the farm unit. BMPs typically used within the watershed include such practices as cross-fencing, stripcropping, waste utilization, grassed waterways, livestock watering facilities, pasture/hay land planting, crop residue use, etc. Cost share assistance for the prescribed BMPs has generally been provided through the North Dakota Section 319 Program, as well as USDA programs such as the Water Quality Incentive Program.

Since the initiation of the project in 1993, project staff have observed many improvements in land management throughout the watershed. During this period, over 30 resource management plans have been developed to reduce erosion on approximately 16,500 acres. This accounts for about 30 percent of the entire watershed. In addition, local sponsors have reported that conservation plans are currently being developed for a significant portion of the remaining acreage within the

watershed. Ultimately, the project sponsors' goal is to develop resource management plans on 80 percent of the agricultural lands within the watershed.

To document the water quality benefits of the project, local staff members have been monitoring water quality trends at four different sites within the project area. Data collected from these sites will be used to evaluate the trends in nutrient and sediment concentrations as BMPs are applied. Although the project has only been active for three years, preliminary review of the water quality data collected thus far does suggest improving trends in water quality. While this positive trend is encouraging, the sponsors will continue to collect additional data to more accurately verify the trends in water quality, as well as identify the factors which were most influential on this trend. Upon completion of the project, an in-depth interpretation of the data will be completed, and a report will be developed describing the project's accomplishments.

Given the success of land treatment efforts and promising water quality trends in the Goodman Creek watershed, the project sponsors have initiated steps to expand their NPS control efforts "district-wide." Recognizing the value and effectiveness of the watershed approach, the sponsors have assigned numerical rankings to several other watersheds within their SCD. Over the long-term, they hope to systematically address all the NPS pollution concerns within priority watersheds. To accomplish this, assessment activities will be initiated in the highest priority watersheds to better define sources and causes of NPS pollution. Upon completion of the assessment activities, the sponsors will schedule and initiate the necessary corrective measures to reduce or prevent identified NPS pollution impacts. Concurrent with the implementation of these corrective activities, the sponsors will also initiate assessment activities in the next highest priority watershed. This process will continue over several years until all priority watersheds have been assessed.

Antelope Creek watershed has been identified as the next highest priority watershed within the sponsors' SCD. As a first step toward addressing water quality issues in this watershed, the project sponsors have applied for and received additional Section 319 funding to conduct preliminary assessment activities. Upon completion of these activities in 1996, the local project sponsors will develop and implement the appropriate NPS pollution control efforts. These efforts and activities are scheduled to be initiated in 1997.

*** Ground Water Monitoring/Assessment ***

Maintenance of the state's ground water resources is also an important component of the North Dakota NPS Pollution Management Program. Nearly all the locally sponsored projects address NPS pollution impacts to ground water to some degree. Locally sponsored activities may include implementation of BMPs, abandoned well sealing demonstrations, and irrigation system management workshops. The NPS program, in cooperation with the Health Department's Ground Water Program, has also supported two ground water assessment studies. These projects include the GTS and the State Ground Water Monitoring Project.

The GTS was created to assess the relative vulnerability of the state's aquifers. The primary goal of this system was to prioritize the aquifers within North Dakota. Of particular concern was the impact agricultural chemicals and fertilizers may have on the state's ground water resources.

The GTS was not initiated to map recharge areas or identify critical areas within aquifers. Rather, the project was implemented to compare aquifers or portions of aquifers with one another. This was accomplished by utilizing the DRASTIC system for evaluating aquifer sensitivities (Aller, et al., 1987). The DRASTIC system involves rating each of the individual parameters for the site and multiplying the rate by a weighting (relative importance) factor to obtain a total DRASTIC score. Parameter weights were assigned for generic contaminant types and also to specifically reflect the agricultural usage of pesticides. Information compiled during the project will be used to provide direction for future ground water quality monitoring efforts.

The State Ground Water Monitoring Project was initiated in June 1994. This project is a direct follow-up to the GTS completed in 1993. Based on information collected through the targeting system, Ground Water Program personnel develop an annual schedule for monitoring specific priority aquifers. Sample collection is accomplished by utilizing existing domestic, stock, irrigation, public supply, and monitoring wells. Within each aquifer, sampling grids are developed, and within each grid block, one well is sampled. The size of the grid blocks are one section or 1 square mile. Wells chosen for sample collection are the shallowest wells in each grid block having verifiable drilling/construction logs. If more than one well is available, and they are screened at the same depths, the one nearest the center of the grid block is sampled. An inventory is also conducted at each well sampled to correlate potential site conditions with water quality observations.

Chapter 4. Coordination With Other Agencies

North Dakota has two rivers of international significance. The Souris River originates in the Canadian province of Saskatchewan, loops through North Dakota, and returns to the province of Manitoba (Figure 1). The Red River of the North originates at the confluence of the Bois de Sioux and Ottertail Rivers near Wahpeton, North Dakota. The Red River flows north, forming the boundary between North Dakota and Minnesota before entering Manitoba. The Health Department participates in two cross-border cooperative efforts to jointly manage these rivers..

The Souris River Bilateral Water Quality Monitoring Group was established on October 26, 1989, in accordance with the Canada-United States Agreement for Water Supply and Flood Control in the Souris River Basin. Objectives of the group include: 1) designing a monitoring plan for the Souris River and 2) overseeing the review, interpretation, and annual reporting of water quality conditions in the Souris River Basin. In addition to the Health Department, other members of the group include Environment Canada, Saskatchewan Environment, Manitoba Environment and Public Safety, the USGS, and EPA.

The other international water quality effort in which the Health Department is involved is the International Red River Water Pollution Board. Created by the International Joint Commission (IJC), the Board monitors Red River water quality. The Board also informs the IJC of trends and exceedances of water quality objectives, documents discharges and control measures, establishes a spill contingency plan, and identifies future water quality issues. Board activities are detailed in annual reports. Other members of the Board include Environment Canada, Manitoba Environment and Public Safety, Manitoba Department of Natural Resources, EPA, and the Minnesota Pollution Control Agency.

The department also participated on various task forces and specialized work groups. One of these is the Garrison Joint Technical Committee. This group consists of technical experts investigating water quality, biota transfer, and hydrologic impacts to Canada if an outlet from Devils Lake is constructed. Another working group is studying methodologies for establishing instream flows on the lower Red River. This group is a partnership among state and federal agencies and private industry.

The International Coalition is an active group with members from Canada, Minnesota, and North Dakota. The purpose of the Coalition is to promote basin-wide management in the Red River Basin by serving as a clearinghouse for information. In February 1996, a Leaders Summit convened to discuss how best to address water resource concerns in the basin. Out of the summit came a commitment to organize a Red River Basin Team to explore how to develop a Red River Basin Water Management Plan. An Interim Planning Group was established and organized into three teams: Organization, Planning, and Budget. The teams produced a series of documents and a set of recommendations to present at the annual International Coalition conference in November 1996. The documents call for the creation of a Red River Basin Board, which would be responsible for coordinating and developing a basin water plan based on local leadership and input, with participation by basin residents.

Cost/Benefit Assessment

Costs associated with municipal point source pollution control have been extensive. Capital investments in the form of additions to and construction of new wastewater treatment facilities account for the largest expenditure of funds. While the Construction Grants and SRF programs have been the major sources of funding, many communities have upgraded wastewater treatment facilities at their own expense.

The SRF replaced the Construction Grants Program in the early 1990s. In the last two years, approximately \$11.7 million has been obligated from the SERF for the construction of wastewater system improvements. During the last ten years, over \$83.2 million has been invested in wastewater system improvements. The cumulative amount since passage of the Clean Water Act in 1972 is approximately \$272 million. In addition to the capital costs, an estimated \$5 million per year is spent operating and maintaining wastewater treatment systems.

While the costs of construction are relatively easy to compile, monetary benefits cannot be so easily quantified. Qualitative benefits include the reduction or elimination of waste loads to receiving waters (Figures 2 and 3 in Part II, Chapter 2) and the elimination of public health threats such as malfunctioning drainfield systems and sewer backups.

Special State Concerns and Recommendations

Surface Water

The following are recommendations the Health Department believes should be considered to further reduce pollution to North Dakota's rivers, streams, lakes, and reservoirs.

Watershed Approach

The "watershed approach" is not a new or unique concept in water quality protection programs. The concept of conducting watershed planning and management first arose with Section 208 of the original 1972 Clean Water Act. The watershed approach is also a key element in EPA's Clean Water Action Plan. This cooperative approach involves state, tribal, federal, and local governments, and the public identifying the watersheds with the most critical water quality problems and then working together to focus resources and implement effective strategies to solve those problems.

It is the Health Department's recommendation that a watershed approach be implemented for all of its water quality monitoring, assessment, and control programs. Local governmental entities (e.g., SCDs, WRDs, county commissions, cities) should be the primary sponsors in implementing watershed management, however.

North Dakota's NPS Pollution Management Program has used the watershed management approach since its inception. The Health Department has also initiated this approach with its monitoring and assessment programs. The state is divided into six watershed basins, with each basin monitored intensively for one year. The purpose is two-fold: 1) to gain a better understanding of all the pollutant sources in a watershed and 2) to set priorities for those water quality problems which are the most severe. With the watershed approach, both point and NPS pollution controls and management measures can be addressed simultaneously to improve water quality.

Other Recommendations

As the dominant land use in North Dakota, agriculture has been the primary focus of the state's NPS Pollution Management Program. Over the past seven years, the Health Department has directed a majority of Section 319 funds to projects addressing agricultural NPS pollution. Given the magnitude and complexity of the agricultural industry, the Health Department has developed a close working relationship with the USDA's NRCS to ensure sufficient resources are available to adequately address NPS pollution within the state. The combined resources from both the Section 319 program and the USDA have proven essential for a balanced NPS Pollution Management Program. To maintain this coordinated effort, continued funding through Section 319 and the USDA programs will be necessary.

It would also be beneficial if state funds, administered through grants to priority NPS pollution watersheds, could be made available. These funds could provide a portion of the state/local match required for Section 319 funding and provide an incentive to sponsors contemplating

volunteer NPS pollution management efforts.

Public awareness of environmental issues, along with the trend toward larger, more concentrated livestock operations, has brought increased concern over these operations and their potential impacts to water quality. The Health Department has taken a more aggressive role in addressing this issue by focusing more attention on public education and by increasing inspections of existing livestock facilities. The department is also developing more thorough and documented guidelines detailing minimum requirements livestock facilities must meet to ensure their waste handling systems are adequate to prevent livestock waste from impacting waters of the state. All new livestock facilities or those that need to be updated must meet these minimum standards. The Health Department will continue to work closely with other entities to implement approved livestock waste systems.

The Health Department has taken an active approach in conducting its Stormwater Program. General permits have been issued for stormwater discharges from industrial, construction, and mining activities. Stormwater pollution prevention plans are constantly being updated. Departmental review of notices of intent is also ongoing. The Stormwater Program has cooperated with the Section 319 NPS Pollution Management Program to assist small communities located within watershed projects to prevent pollutants from entering runoff.

The Health Department is also working to bring stakeholders together in an effort to implement Phase II of the Stormwater Program. The department will continue these efforts until a successful program has been developed to addresses construction disturbances under five acres, light industry, and small municipalities.

Biological assessment techniques and methods should be further incorporated into the Health Department's water quality monitoring program. It is generally believed that the instream biological community (e.g., fish aquatic insects, algae) exposed to pollutant stresses on a continual basis is the best measure of aquatic life use.

The Health Department is in the process of revising its standards of water quality. The standards delineate the policy of the state which is to protect, maintain, and improve the quality of water for use as public and private water supplies; for propagation of wildlife, fish, and aquatic life; and for domestic, agricultural, industrial, recreational, and other legitimate beneficial uses. These standards identify specific numeric criteria for chemical, biological, and physical parameters. The specific numeric standard assigned to each parameter ensures protection of the beneficial uses for that classification.

The anti-degradation policy is also being refined by the Health Department. Under this policy and implementation procedure, all waters of the state are afforded one of three different levels of anti-degradation protection. All existing uses, and the level of water quality necessary to protect those uses, shall be maintained and protected. Anti-degradation requirements are necessary whenever a regulated activity is proposed that may have some impact on water quality and/or the ability of a waterbody to maintain its beneficial use designation. The department will conduct an anti-degradation review of all proposed regulated activities affecting waters of the state. The level of

detail of the review will depend upon the anti-degradation protection applicable to various classes of water.

EPA's Section 314 Clean Lakes Program has been recognized as a success by both the private and public sectors. Recreational and fishing benefits have been restored on untold numbers of lakes nationwide as a result of Clean Lakes funding. In North Dakota, both Spiritwood and Mirror Lakes were improved and restored with Section 314 funding. While there is an ever growing list of potential clean lakes projects, funds have disappeared. Federal funding for the Clean Lakes Program should be re-established, and limited state funds should be made available to local sponsors willing to invest in the restoration of lakes in North Dakota.

Ground Water

Many different federal, state, and local agencies are concerned with ground water quality issues across the nation. In North Dakota, agencies including the USGS, EPA, the Health Department, and the SWC are involved in the collection, analysis, and study of various ground water issues. Some inherent problems occurring with multiple agencies sharing responsibility for ground water are inadequate communication and data incompatibility.

Communication between all levels of governmental agencies is crucial to management of water resources in North Dakota. Without a good communication network, different agencies may duplicate what has already been accomplished. Consistent, compatible data shared between different agencies is also essential. A standard format into which data is collected (quality assurance/quality control, standard operating procedures) and stored is important in any scientific endeavor. With the growth of GIS in the ground water field, a standard format should include those elements critical to GIS.

Conclusion

There have been many improvements in water quality since passage of the Clean Water Act in 1972. Secondary wastewater treatment has been achieved for every municipality in the state. Wellhead protection programs are being developed for public drinking water supplies relying on ground water. Increased inspections will assure that concentrated animal feeding operations are managed in such a way that waste and runoff will not reach surface or ground water resources. Biological measures are being integrated into ambient monitoring for water quality assessment. These are but a few of the successes. Much remains to be done, however, if the goal of restoring and maintaining the chemical, physical, and biological integrity of the state's and nation's waters is to be achieved.

PART III. SURFACE WATER ASSESSMENT

Chapter 1. Surface Water Quality Monitoring Program

Rivers and Streams Monitoring and Assessment

Historically, water quality monitoring conducted by the department consisted of a statewide network of chemical monitoring stations. Many of these stations were located immediately below point source discharges or near the confluences of major streams. Sampling at these stations ranged from a quarterly to a monthly sampling frequency. Typical water quality variables sampled for and analyzed were temperature, DO, pH, major ions, nutrients (i.e., total phosphorus, ammonia, nitrate), and fecal coliform bacteria. Trace elements were also sampled and analyzed at a few select sites across the state. At its peak, in 1993, the Health Department's monitoring network included 61 ambient chemical monitoring sites on 31 rivers and streams. The primary purpose of this historic monitoring program was to assess the general chemical character of the state's rivers and streams and, to the extent practical, assess point source discharge compliance with *State Water Quality Standards*.

While effective in its original purpose, this historic strategy was largely ineffective in assessing trends in water quality across the state, nor did it provide enough spatial resolution necessary to conduct beneficial use assessments for any significant number of stream miles in the state. Where data was available, it was still difficult to make beneficial use assessments, since much of it was only indirectly related to beneficial use impairment. For example, copper concentrations which exceed the state copper standard are believed to have a toxic effect on the biological community. Therefore, the occurrence of copper concentrations exceeding the state standard should be an indicator of potential aquatic life use impairment. It is not a substitute for direct measures of the biological community as a measure of aquatic life use impairment, however. In addition, traditional monitoring also ignored the effects of other pollutants (e.g., nutrients, sediment) and the effects of habitat alterations on the aquatic life use of our streams.

In response to this growing need for better water quality assessment information, the department initiated a biological monitoring program in 1993 to run through 1994. This program, a cooperative effort with the Minnesota Pollution Control Agency and the USGS's Red River National Water Quality Assessment Program, involved approximately 100 sites in the Red River Basin. The result of this initial program was development of an IBI for fish in the Red River Basin. This program continued in 1995, with an additional 50 biological monitoring sites in the Upper Red River Basin, including the Sheyenne River and its tributaries. Biological monitoring was also expanded in 1995 to include macroinvertebrate sampling. This basin approach to biological monitoring allowed for more intensive water quality monitoring and assessment. The result has been better resolution in the Health Department's monitoring program and a direct assessment of aquatic life use support for the state's rivers and streams, rather than relying on surrogate measures such as chemical concentration data.

At the same time the department was increasing its commitment to biological monitoring, it reduced the number of ambient chemical monitoring sites from the 61 operated in 1993 to 27 sites

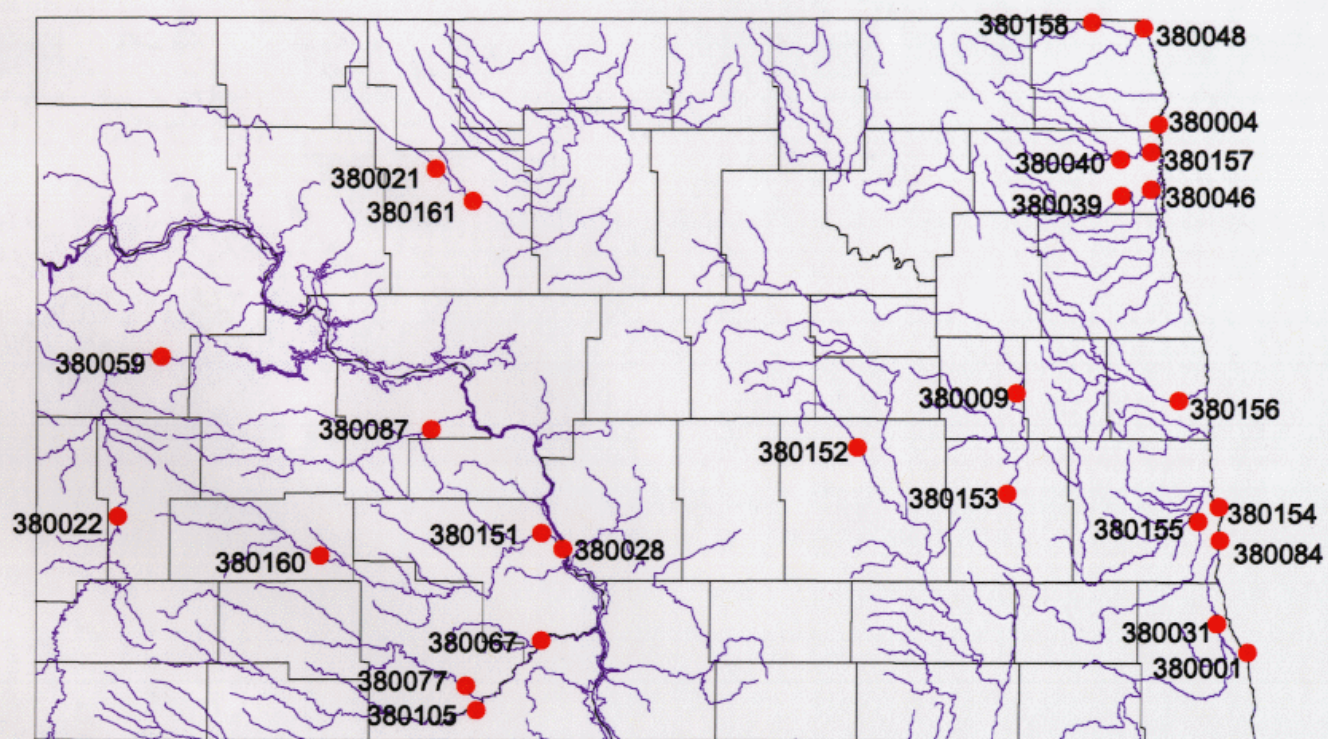
in 1994 (see Figure 4 and Table 6) The 27 sites established in 1994 were a combination of sites established as part of the historic monitoring network, plus some new sites. Where practical, sites were co-located with USGS flow gauging stations, thereby facilitating the analysis of chemical data with stream hydrologic data. All of these sites were established as basin or sub-basin integrator sites, where the chemical character measured at each of these sites reflects water quality effects in the entire watershed. It is the department's intention to maintain these as long-term monitoring sites for the purpose of assessing water quality trends and to describe the general chemical character of the state's major river basins.

In addition to sites maintained by the Health Department, the USGS also maintains and operates several water quality monitoring sites which provide data used by the department for assessment purposes. Many of these sites are maintained through cooperative agreements with other agencies (e.g., SWC, U. S. Bureau of Reclamation, COE) or through international agreements (e.g., the Souris River Bilateral Agreement).

Future water quality monitoring and assessment plans call for the integration of biological and chemical monitoring through the basin approach. In 1996, biological monitoring (macroinvertebrate and fish) will continue in the lower Red River Basin. In 1997, biological monitoring will be complemented with intensive water chemical monitoring in the Souris River Basin. This basin monitoring assessment strategy will continue in the James River, Upper Missouri River/Lake Sakakawea, and Lower Missouri River/Lake Oahe basins in 1998, 1999, and 2000, respectively. This assessment process will then be repeated in 2001, beginning with the Red River Basin.

In addition to the 27-station, ambient chemical monitoring network and the annual basin assessment program, the Health Department cooperates with local project sponsors (e.g., SCDs and WRBs) in small watershed monitoring and assessment projects. The approach of these monitoring and assessment projects is similar to the highly successful Clean Lakes - Phase I Diagnostic/Feasibility Studies. These projects entail intensive water quality monitoring, stream flow measurements, land use assessments, and biological assessments. Where lake water quality is a concern, lake monitoring is also included in the sampling and analysis plan. The goal of these small watershed monitoring projects is to estimate pollutant loadings to the lake or stream and, where appropriate, set target load reductions necessary to improve beneficial uses (e.g., aquatic life, recreation). Most of these projects are followed by Section 319 NPS Pollution Management Program Watershed Implementation Projects (see Part II, Chapter 3. NPS Pollution Control Program).

Figure 4. 1995 Sampling Sites - Ambient Stream Monitoring - Statewide



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Figure 4. 1994 - 1995 Sampling Sites - Ambient Stream Monitoring - Statewide

Table 6. 1994 and 1995 Sampling Sites - Ambient Stream Monitoring - Statewide

<u>Storet #</u>	<u>River</u>	<u>Location</u>
38001	Bois de Sioux	Wahpeton
38004	Red	Drayton
38009	Sheyenne	Cooperstown
380021	Des Lacs	Foxholm
380022	Little Missouri	Medora
380028	Missouri ¹	Bismarck
380031	Wild Rice	Abercrombie
380033	Bald Hill Creek ²	Dazey
380039	Forest	Near Minto
380040	Forest	East of Minto
380046	Park	At Hwy I-94
380048	Pembina	South of Pembina
380059	Little Missouri	Hwy 85
380067	Cannonball	South of Breien
380077	Cedar Creek	South of Raleigh
380084	Red	Near Fargo
380087	Knife	South of Hazen
380105	Cannonball	Raleigh
380151	Heart	West of Mandan
380152	Pipestem Creek	West of Pingree
380153	Sheyenne	Baldhill Dam
380154	Red	South of Fargo
380155	Sheyenne	West Fargo
380156	Goose	Hillsboro
380157	Park	Grafton
380158	Pembina	Neché
380160	Heart	South of Richardton
380161	Souris	West of Minot

¹Sampled only in 1994.

²Sampled only in 1995.

Lakes and Reservoirs Monitoring and Assessment

In 1991, through a grant from the EPA Clean Lakes Program, the Health Department initiated the LWQA Project. North Dakota's LWQA Project is presently addressing its fifth set of lakes and is in its sixth year of data collection and analysis. To date, data collection, data analysis, and reports have been completed on 87 lakes and reservoirs. Five additional reservoirs were revisited in 1994 to investigate the effects, if any, from flooding (see Table 7). The objective of the assessment project is to describe the general physical and chemical condition of the state's lakes and reservoirs.

Table 7. North Dakota Lakes and Reservoirs Assessed From 1991 Through 1995

1991-92 Lakes

Armourdale Dam	Harvey Dam	North Golden Lake
Bisbee-Big Coulee Dam	Indian Creek Dam	Northgate Dam
Blacktail Dam	Kulm-Edgeley Dam	Pheasant Lake
Brewer Lake	Lake Hoskins	Rice Lake
Brush Lake	Lake LaMoure	Short Creek Dam
Cedar Lake	Long Lake	South Golden Lake
Clausen Springs Dam	Matejcek Dam	Strawberry Lake
Crooked Lake	McGregor Dam	Velva Sportsman's Dam
Epping-Springbrook Dam	Nieuwsma Dam	Welk Dam
Green Lake	North Carlson Lake	Whitman Dam

1992-93 Lakes

Alkali Lake	Heinrich Martin Dam	Odland Dam
Arnegard Dam	Hiddenwood Lake	Patterson Lake
Balta Dam	Kota-Ray Dam	Red Willow Lake
Baukol Noonan Dam	Lake Elsie	Riverdale Spillway Pond
Beaver Lake	Lake Isabel	Sheep Creek Dam
Braddock Dam	Lake Metigoshe	Silver Lake
Carbury Dam	Lake Tschida	Skjermo Lake
Clearwater Lake	Lake Williams	Smishek Lake
Crown Butte Dam	LaMoure Dam	Sweet Briar Dam
Dead Colt Creek Dam	McVile Dam	Tolna Dam
Fordville Dam	Mirror Lake	Warsing Dam
Froelich Dam	North Lemmon Lake	White Earth Dam

1993-94 Lakes

East Park Lake	Nelson Lake	Schlecht-Weixel Dam
Fish Creek Dam	New Johns Lake	West Park Lake
Heckers Lake	Nygren Dam	Wilson Dam
Lehr Dam	Schlecht-Thom Dam	

1994-95 Lakes

Bowman-Haley Reservoir	Lake Brekken	McDowell Dam
Danzig Dam	Lake Holmes	South Buffalo Cap
Davis Dam	Leland Dam	Spring Lake Dam
Dickinson Dike		

1994 Flood Lakes

Brewer Lake	Renwick Dam	Velva Sportsman's Dam
	Sweet Briar Dam	

Table 7. (cont.) North Dakota Lakes and Reservoirs Assessed From 1991 Through 1995

1995-96 Flood Lakes

Buffalo Lodge Lake
Carbury Dam
Carpenter Lake
Dion Lake
George Lake

Gravel Lake
Hooker Lake
Jensen Lake
Lake Upsilon
Long Lake

Pelican Lake
School Section Lake
Strawberry Lake

The lakes and reservoirs targeted for assessment were chosen in conjunction with the North Dakota Game and Fish Department. Criteria used during the selection process were geographic distribution, local and regional significance, fishing and recreational potential, and relative trophic condition. Lakes without much historical monitoring information were given the highest priority.

The results from the 87 lakes and reservoirs have been prepared in a functional atlas-type format. Each lake report discusses the general description of the waterbody, general water quality characteristics, plant and phytoplankton diversity, trophic status estimates, and watershed condition. The following is a brief description of the sections found in each lake assessment, the techniques used in sample collection, and data interpretation.

General water quality for lakes and reservoirs sampled as part of the LWQA Project is described using samples collected in the deepest areas of the waterbody. Samples are collected three times during the assessment period: twice during the summer and once during the ice-cover period. A complete list of analyzed water quality variables is provided in Table 8.

Table 8. Water Quality Parameters Analyzed During the LWQA

Total alkalinity (CaCO ₃)	Sodium absorption ratio
Ammonia (NH ₃)	Conductivity
Carbonate (CO ₃)	Total Kjeldahl nitrogen
Chloride (Cl)	Nitrate + nitrite as N
Total hardness as calcium (as CaCO ₃)	Calcium (Ca)
pH	Iron (Fe)
Percent sodium	Magnesium (Mg)
Sulfate (SO ₄)	Manganese (Mn)
TDS	Potassium (K)
Total phosphate as phosphorus	Sodium (Na)
Cation sum	Anion sum

Samples are collected at three discrete depths if the lake is greater than 4 meters deep or thermally stratifies, and at two depths if the lake was 3.5 meters deep or less. During periods of thermal stratification, samples are collected at: 1) the 1-meter depth interval to represent the epilimnion, 2) just below the thermocline to represent the transition zone between the epilimnion and the hypolimnion, and 3) just above the bottom to represent the hypolimnion. In lakes that exceed 10 meters and are experiencing well-defined thermal stratification, a fourth sample is collected just above the thermocline to identify any significant changes in the epilimnion.

A volume-weighted mean is calculated for each lake using this stratified sampling technique to describe its general chemical characteristics. The volume-weighted mean is calculated by weighting the analyzed water quality variable by the percentage of water volume represented at each depth interval. For example, if the epilimnion represented 60 percent of the total water volume, the transition zone 10 percent, and the hypolimnion 30 percent, the concentrations of the corresponding parameters would be multiplied by 0.6, 0.1, and 0.3, respectively. The resulting concentrations would then be totaled to equal the volume-weighted mean.

A qualitative survey of the macrophyte community is also conducted in each lake or reservoir. The survey is conducted in either July or August to coincide with the period of maximum plant growth. The survey is performed by sampling transects bisecting the entire width of the waterbody. The macrophyte specie(s) present are identified and relative density determined at 1-meter intervals.

Phytoplankton and chlorophyll-a samples are collected twice at approximately one-month intervals during July and August. A 6-foot depth, integrated sample is collected over the deepest area of the lake. A measured amount of sample is filtered for chlorophyll-a analysis, while an aliquot of the sample is preserved for phytoplankton identification and enumeration.

One of the most useful measures of lake water quality is trophic condition. Trophic condition is a means of expressing a lake's productivity as compared to other lakes in a district or geographical area. In general, oligotrophic lakes are deep, clear lakes with low primary production, while eutrophic lakes are shallow and contain macrophytes and/or algae. Eutrophic lakes are considered moderately to highly productive.

The trophic condition or status is assessed for each of the lakes and reservoirs included in the LWQA. Accurate trophic status assessments are essential for making sound preservation or improvement recommendations. In order to minimize errors in classification, a multiple indicator approach was initiated.

Since trophic status indices specific to North Dakota waters have not been developed, Carlson's TSI was chosen to delineate the trophic status of an LWQA Project lake or reservoir. To create a numerical TSI value, Carlson's TSI (Carlson, 1977) uses a mathematical relationship based on three indicators: secchi disk transparency in meters, surface total phosphorus in $\mu\text{g L}^{-1}$, and chlorophyll-a in $\mu\text{g L}^{-1}$.

This numerical value then corresponds to a trophic condition ranging from 0 to 100, with increasing values indicating a more eutrophic condition. Carlson's TSI estimates are calculated using the following equations:

Trophic status based on secchi disk (TSIS):

$$\text{TSIS} = 60 - 14.41 \ln (\text{SD})$$

Where SD = Secchi disk transparency in meters.

Trophic status based on total phosphorus (TSIP):

$$\text{TSIP} = 14.20 \ln (\text{TP}) + 4.15$$

Where TP = Total phosphorus concentration in $\mu\text{g L}^{-1}$.

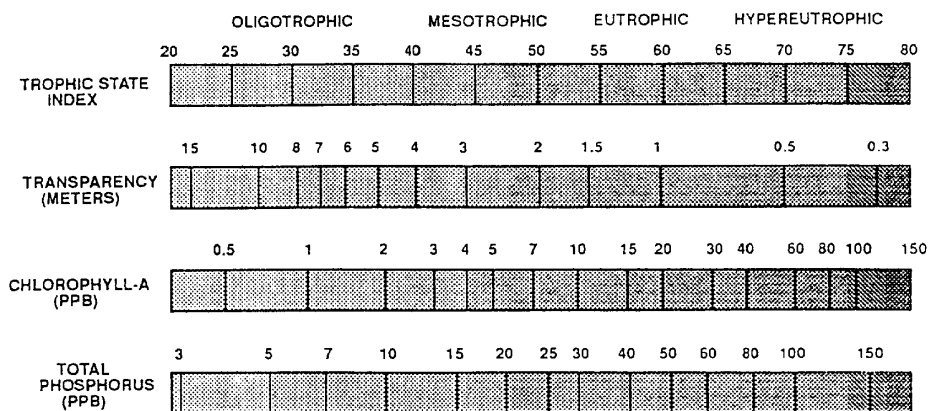
Trophic status based on chlorophyll-a (TSIC):

$$\text{TSIC} = 9.81 \ln (\text{TC}) + 30.60$$

Where TC = Chlorophyll-a concentrations in $\mu\text{g L}^{-1}$.

Trophic status using Carlson's TSI is depicted graphically in Figure 5. A major drawback to using Carlson's TSI is that it was developed for lakes that are primarily phosphorus limited. Because most North Dakota lakes and reservoirs have an abundance of phosphorus, ancillary information (e.g., DO concentrations, frequency of nuisance algal blooms, phytoplankton community structure, and macrophyte biomass) was combined with Carlson's numerical TSI to prevent misclassification. Since interpretation of ancillary information can be subjective, the largest available database (incorporating both historical and LWQA data) was used to promote consistency between assessing scientists.

Due to variations in geological and ecological regions and lake type (manmade, natural), numerical trophic status assessments are not assigned to individual waterbodies during the LWQA Project. Instead, the general trophic condition of the waterbody (e.g., mesotrophic, eutrophic, hypereutrophic) is identified.



Each LWQA Project lake was also assessed for contaminant pollutants (i.e., trace elements and organic compounds). Bottom sediments are collected from the inlet, littoral, and deepest areas of each lake or reservoir assessed. One sediment sample is collected at each location using a standard 2-inch core sampler. Each sample is analyzed for selected trace elements, PCBs, and organic compounds. Contaminants analyzed in the sediment samples are listed in Table 9.

An effort is made to collect littoral samples in areas typical of each individual lake. For purposes of the LWQA Project, the littoral area is defined as the shallow water shoreline area where submergent vegetation is present. The deepest area of the lake is defined using lake maps and a depth finder. Sediment samples from the deepest area are collected at the same location as water quality samples. Inlet samples are collected as far into the center of the inlet as possible.

Fish sampled for contaminant analysis are collected in cooperation with the North Dakota Game and Fish Department. At each lake or reservoir, an effort is made to collect at least two types of fish from the following groups: bottom feeders (e.g., white sucker, carp, bullhead), piscivores (e.g., northern pike, walleye, bass), and insectivores (e.g., crappie, bluegill). Table 9 lists the contaminants analyzed in whole fish samples.

Table 9. Contaminants Analyzed and Their Detection Limits in Sediment and Whole Fish Samples Collected During the 1991-1992 and 1992-1993 LWQA Projects

Parameter	Detection Limit($\mu\text{g g}^{-1}$)	Parameter	Detection Limit($\mu\text{g g}^{-1}$)
Copper	1.400	Endosulfan I	0.002
Zinc	0.900	Endosulfan II	0.002
Barium	0.900	Endosulfan Sulfate	0.002
Mercury	0.010	Endrin	0.002
Chromium	0.020	Heptachlor	0.001
Arsenic	0.020	Methoxychlor	0.004
Selenium	0.100	Hoelon	0.010
Cadmium	0.020	PCB (Total)	0.010
Lead	0.020	Nonachlor	0.010
Aldrin	0.001	Alachlor	0.001
BHC-Alpha	0.001	Parathion Ethyl	0.003
BHC-Beta	0.001	Parathion Methyl	0.002
Lindane	0.001	Fenvalerate	0.020
Chlordane	0.002	Triallate	0.002
DDD	0.001	Trifluralin	0.001
DDE	0.001	Pendimethalin	0.002
DDT	0.001	Metolachlor	0.001
Dieldrin	0.001		

¹Detection limit values are based on a 1-gram sample.

In addition to the chemical monitoring and analysis, a land use assessment is completed for each lake. Each lake's watershed is assessed to identify the major sources of point and NPS pollution. Land use and land use practices are inventoried by interviewing local NRCS field office staff and state NRCS personnel. This inventory was verified in the field in the late fall. An aerial watershed survey was also performed on approximately one-third of all lakes assessed.

Point source assessments were accomplished for each watershed with the assistance of the department's Permit Program staff. All contributing point sources were identified, and an estimate was made of the probable nutrient and organic loading to each lake or reservoir and its impact.

Plans are to continue the current LWQA Project through the 1996-1997 field season with an additional 10 to 12 lakes. Once these lakes are completed, it is the department's intention to integrate the LWQA program with the department's basin approach. Under this monitoring strategy, all surface water quality monitoring and assessment activities would be coordinated within a basin each year. As monitoring and assessment plans are developed for a basin, lakes and reservoirs within that basin will be identified and prioritized for monitoring. It is anticipated that a maximum of five lakes will be sampled in each basin each year.

In addition to their inclusion in the annual LWQA Project, Devils Lake and Lake Sakakawea have received special attention. Lake Sakakawea experienced record low water levels through 1993

and since that time has increased in elevation some 23 feet. Similarly, Devils Lake has increased in elevation 15 feet since 1993. In response to questions regarding water quality changes resulting from these water level increases, the department initiated a comprehensive water quality monitoring program in 1992 for Lake Sakakawea and in 1993 for Devils Lake. Each lake is sampled approximately five times per year, including once during the winter. Current plans are to continue this program through 1996 for Lake Sakakawea and indefinitely for Devils Lake.

Fish Tissue Monitoring

Analysis of fish tissue has become a regular part of the Health Department's water quality program. Based on current data, a fish consumption advisory for mercury exists for 31 lakes and two rivers in North Dakota. The advisory is not intended to discourage people from eating fish, but offers advice on how fish caught in the state can be safely eaten. The monitoring of fish flesh for mercury and other contaminants continues each year with the collection of fish from additional rivers and lakes, as well as from those under existing consumption advisories. The fish consumption advisory is expanded and updated annually. Information regarding each waterbody affected by mercury is available from EPA's National Inventory of Fish Consumption Advisories. The EPA contact person is Jeff Bigler (202-260-1305).

Biological Monitoring

The impetus for biological monitoring stems from the Clean Water Act objectives for restoring and maintaining not only the chemical integrity of the state's surface waters, but also the physical and biological integrity. Biological monitoring for water quality started in North Dakota in 1993, but efforts were postponed to 1994 due to heavy rains and flooding rivers. The first project started as a cooperative venture with the Minnesota Pollution Control Agency, EPA Regions V and VIII, and the USGS's National Water Quality Assessment program. Natural resource agencies from both states also cooperated in this effort.

The IBI was used to focus on the Lake Agassiz Plain ecoregion (commonly known as the Red River Valley). The IBI uses a multi-metric framework to interpret biologically based expectations for assessing water resource quality. Community-based structural and functional attributes are a principal component of numerical biological criteria. Ultimately, it is the goal of the Health Department to establish biological criteria as: 1) narrative general statements of attainable conditions of biological integrity and water quality, or 2) numerical indices that serve as biological criteria and describe expected attainable community attributes for different designated uses.

In 1994, 111 different samples were collected in the Red River Valley to focus on the fish community. Sampling sites were located throughout the ecoregion. Efforts were made to locate sites away from known areas of pollution (e.g., sewage outfalls) and away from large tributary connections. Sample locations were divided into three different categories dependent on drainage size. Headwater sites were considered to be those with drainages of less than 200 square miles. Moderate-sized rivers had drainages between 200 and 1500 square miles, and large river sites had drainage areas of over 1500 square miles. Twelve metrics or definitions describing the fish community were used to establish a numerical score for each site. Most metrics are similar for

each drainage basin. However, subtle differences are included in each description of the fish community specific for a particular drainage (i.e., headwater, moderate-sized river, large river).

Efforts in 1995 were concentrated along a longitudinal gradient of the Sheyenne River and a few of its tributaries. Sampling in 1995 also included revisiting sites in the upper end of the Lake Agassiz Plain ecoregion in North Dakota. Sampling efforts focused not only on the fish community but the macroinvertebrate community as well. Thirty-nine fish samples and 48 macroinvertebrate samples were collected for analysis. New biological indices for the macroinvertebrate community are being formulated. Any revisions to the fish community metrics specific to the Sheyenne River and/or the Lake Agassiz Plain will also be examined.

Chapter 2. Assessment Methodology

The purpose of this report, termed the *State Water Quality Assessment Report* (otherwise known as the Section 305(b) Report), is to assess and report on the extent to which beneficial uses of the state's rivers, streams, lakes, reservoirs, and wetlands are met. Section 305(b) of the Clean Water Act requires states to submit this assessment report every two years; therefore, the information presented in this report is for the reporting period of 1994-1995. This report is not a trends report, nor should the data or information in this report be used to assess water quality trends. Factors which complicate and prohibit comparisons between reporting years include changes to the estimated river and stream miles (e.g., during this reporting cycle, estimated river and stream miles increased from 11,868 miles to 53,989 miles, using RF3), and changes in the number of sites and the quality of data upon which assessment information is based.

Waterbody Delineation Method

With an estimated 53,989 miles of rivers and streams, and 650,380 acres of lakes, it is impractical to assess each and every mile of stream or every acre of lake every two years for this report. However, the department believes it is important to accurately assess those waters for which beneficial use assessment information is available, and to account for those stream miles and lake acres that are not assessed every two years. As a result, the department has adopted the WBS to manage water quality assessment information for the state's rivers, streams, lakes, and reservoirs.

The WBS is an "accounting"/database management system developed by EPA, which provides a standard format for water quality assessment information. It includes a software program for adding and editing assessment data, generating reports, and transferring assessment data between the personal computer and EPA mainframe databases. Assessment data, as compared to raw monitoring data, describes the overall health of the waterbody by describing beneficial use impairment and, for those waterbodies where beneficial uses are threatened or impaired, the cause and source of pollution affecting the beneficial use.

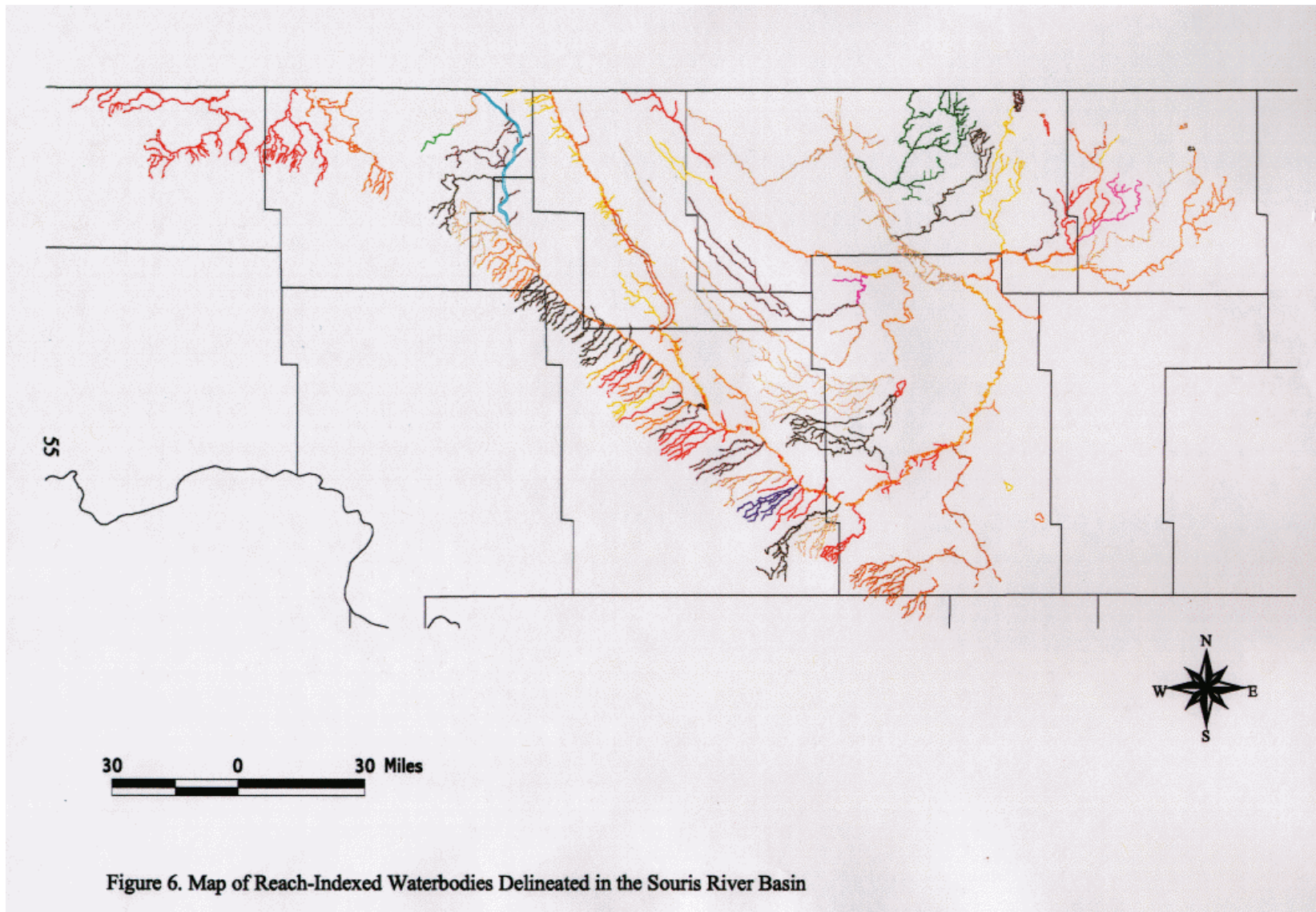
To create the state's WBS database management system, the state's 53,989 miles of rivers and streams and 219 lakes and reservoirs have been delineated into 1,615 discreet waterbodies. This includes 1,396 river and stream waterbodies and 219 lake and reservoir waterbodies. Each of these waterbodies are then assessed individually, based on data availability. The individual waterbody assessments are then compiled through the WBS reporting software into summaries, which form the basis for this report. In order to delineate waterbodies used in the WBS, the department followed a general set of guidelines:

1. Each waterbody was within the eight-digit USGS hydrologic unit.
2. Each river and stream waterbody was comprised of stream reaches of the same water quality standards classification (I, IA, II, or III).
3. To the extent practical, individual waterbodies were within the same ecoregion.

4. Mainstem perennial rivers were delineated as separate waterbodies. Where these rivers join with another major river or stream within the eight-digit hydrologic unit, the river was further delineated into two or more waterbodies.
5. Tributary rivers and streams, which are named on USGS 1:100,000 scale planimetric maps, were delineated as separate waterbodies. These waterbodies may have been further delineated, based on stream order or water quality standards classification.
6. Unnamed ephemeral tributaries to a delineated waterbody were consolidated into one unique waterbody. This was done primarily for accounting purposes, so that all tributary stream reaches identified in the RF3 are included in the WBS.
7. Stream reaches, which were identified in the RF3 and on USGS 1:24,000 scale maps and which did not form either an indirect or direct hydrologic connection with a perennial stream, were not included in the WBS. This would include small drainages which originate and flow into closed basin lakes or wetlands. (Note: This delineation criteria does not apply to tributaries to Devils Lake.)

The WBS provides an efficient accounting and data management system. It also allows for the graphical presentation of waterbody assessment information by linking waterbody assessments contained in the WBS to the RF3 river reach file through geographic information systems (GIS). In order to facilitate the GIS datalink, the department is currently in the process of "reach indexing" waterbodies in the WBS to the RF3 file. The product of this process is a GIS coverage which can be used to graphically display water quality assessment data entered in the WBS. Reach indexing has been completed for the Souris River Basin. A map depicting each of the reach-indexed waterbodies delineated in the Souris River Basin is provided in Figure 6.

Figure 6. Map of Reach-Indexed Waterbodies Delineated in the Souris River Basin



Beneficial Use Designation

As stated previously, the purposes of this report are to: 1) describe the extent to which beneficial uses of the state's rivers, streams, lakes, and reservoirs are being met and 2) describe the causes and sources of pollutants limiting beneficial use attainment for those waterbodies not meeting beneficial uses. In order to conduct this assessment, each waterbody must be assigned beneficial uses. Beneficial uses are assigned to waterbodies utilizing the *State Water Quality Standards*. These regulations define the protected beneficial uses of the state's rivers, streams, lakes, and reservoirs.

Four beneficial uses (aquatic life, recreation, drinking water, and fish consumption) were assessed for purposes of this report. All waterbodies entered into the WBS and, therefore, all stream classes (I, IA, II, and III) and all lake classes (1-5) were assigned aquatic life and recreation beneficial uses. All Class I, IA, and II rivers and streams and all lakes were assigned the drinking water beneficial use. The fourth beneficial use, fish consumption, has been assigned to all Class I, IA, and II rivers and streams, to those Class III streams known to provide a sport fishery, and to all Class 1 through 4 lakes. While not specifically identified in state standards, the fish consumption use is protected through both narrative and numeric human health criteria specified in the State Water Quality Standards. Other beneficial uses identified in the State Water Quality Standards are agriculture (e.g., stock watering, irrigation), and industrial (e.g., washing, cooling). These uses were not assessed as part of this report, but are presumed to be fully supporting.

Beneficial Use Assessment Methodology for Rivers and Streams

The following is a description of the assessment methodology or decision criteria for each beneficial use assigned to rivers and streams in the state.

In general, waterbody assessments made for this report fall into two categories: evaluated and monitored. "Evaluated" waterbodies are those for which the use support decision was based on information other than site-specific chemical, physical, or biological monitoring data collected between 1991 and 1995. Types of evaluated assessment information used for this report include land use information, known locations of pollutant sources, spill or fish kill incidents, water quality information provided by local residents or resource managers (e.g., SCDs or WRDs), and water quality monitoring data over five years old. Assessments which are extrapolated from data or assessments from adjacent waterbodies were also considered evaluated.

Waterbody assessments defined as "monitored" are based on fixed station physical and chemical monitoring data and biological data collected within the last five years. Physical and chemical monitoring data used in this report came from two primary data sources: the USGS and the Health Department (see section entitled "Surface Water Quality Management Program"). Physical and chemical monitoring data used for this assessment report included conventional pollutant (e.g., DO, pH, ammonia, fecal coliform bacteria) and toxic pollutant (e.g., trace elements and pesticides) data collected between 1991 and 1995. Biological monitoring data used for this report included fish community and macroinvertebrate community data collected by the department in 1993, 1994, and 1995. If more than one site occurred within a delineated

waterbody, data from all sites and for all years was pooled for analysis.

As stated previously, beneficial use was assessed for aquatic life, recreation, drinking water, and fish consumption. The following is the beneficial use decision criteria utilized for this assessment:

1. Aquatic Life

Aquatic life use, or biological integrity, can be defined as “the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats of the region.” (Karr, 1981) When aquatic life is similar to that of natural habitats in the region, it is assessed as “fully supporting.” When it is not similar, it is assessed as either “fully supporting but threatened,” “partially supporting,” or “not supporting,” depending upon the degree of impairment.

Where assessment information or data were not available, aquatic life use was considered “not assessed.” Where chemical data were available, aquatic life use support assessment decisions were made using the following decision criteria.

In general, aquatic life use determinations utilizing chemical data were based on the number of exceedances of *State Water Quality Standards* for DO and on the number of exceedances of the acute or chronic standards for unionized ammonia, arsenic, cadmium, copper, cyanide, lead, nickel, selenium, silver, zinc, and chromium. Where available, dissolved metals data were used to make use support decisions. Where total recoverable metals data were available, the total recoverable value was converted to a dissolved metals value using the recommended conversion factors provided in Table 10.

Table 10. Recommended Factors for Converting Total Recoverable Metal Criteria to Dissolved Metal Criteria

METAL	RECOMMENDED CONVERSION FACTORS	
	CMC ^a	CCC ^a
Arsenic (III)	1.000	1.000
Cadmium ^b Hardness = 50 mg/L Hardness = 100 mg/L Hardness = 200 mg/L	0.973 0.944 0.915	0.938 0.909 0.880
Chromium (III)	0.316	0.860 ^c
Chromium (VI)	0.982	0.962
Copper	0.960	0.960
Lead ^b Hardness = 50 mg/L Hardness = 100 mg/L Hardness = 200 mg/L	0.892 0.791 0.690	0.892 0.791 0.690
Nickel	0.998	0.997
Selenium	0.922	0.922
Zinc	0.978	0.986

^a CMC: Criterion Maximum Concentration
CCC: Criterion Continuous Concentration

^b The recommended conversion factors (CFs) for any hardness can be calculated using the following equations:

Cadmium

CMC: $CF = 1.136672 - [(\ln \text{hardness}) (0.041838)]$

CCC: $CF = 1.101672 - [(\ln \text{hardness}) (0.041838)]$

Lead

CMC and CCC = $1.46203 - [(\ln \text{hardness}) (0.145712)]$

where:

(ln hardness) = natural logarithm of the hardness. The recommended CFs are given to three decimal places because they are intermediate values in the calculation of dissolved criteria.

^c This CF applies only if the CCC is based on the test by Stevens and Chapman (1984). If the CCC is based on other chronic tests, it is likely that the CF should be 0.590, 0.376, or the average of these two values.

Source: Stephen, C. E., 1995

Fully Supporting: For DO, the standard of 5 mg/L (minimum) was not exceeded at any time. For unionized ammonia and other toxic pollutants (e.g., trace elements and organics), the acute or chronic standard was not violated at any time between 1991 and 1995.

Fully Supporting But Threatened: For DO, the standard of 5 mg/L was exceeded in less than 10 percent of the samples. For unionized ammonia and other individual toxic pollutants, no more than one violation of the acute chronic standard occurred during any consecutive 3-year period between 1991 and 1995. Aquatic life use support was also assessed as fully supporting but threatened where land use, stream condition, or habitat were believed (using best professional judgement) to cause a threat to aquatic life.

Partially Supporting: For DO, the 5 mg/L standard was exceeded in 11 to 25 percent of the measurements taken between 1991 and 1995. For unionized ammonia and other toxic pollutants, the acute or chronic standard was exceeded more than once, but in less than 10 percent of the samples within any consecutive 3-year period between 1991 and 1995.

Not Supporting: For DO, the 5 mg/L standard was exceeded in more than 25 percent of the samples collected between 1991 and 1995. For unionized ammonia and other toxic pollutants, the acute or chronic standard was exceeded in more than 10 percent of the samples collected between 1991 and 1995.

While chemical data provides an indirect assessment of aquatic life use impairment, direct measures of the biological community are believed to be a more accurate assessment of aquatic life use or biological integrity. As stated previously, the department began a stream biological monitoring and assessment program in 1993. Since then, fish community assessments have been conducted at 64 sites in the Red River Basin. Of these, stream macroinvertebrate assessments were conducted at 35 sites.

The department has adopted the “multi-metric” approach to assess biological integrity or aquatic life use support for rivers and streams. The multi-metric approach assumes that various measures of the biological community (e.g., species richness, species composition, trophic structure, individual health) respond to human-induced pollutant loadings or habitat alterations. Each measure of the biological community, termed a “metric,” is evaluated and scored on a 1, 3, 5 point scale. Using this method, the higher the score, the better the biological condition and, presumably, the lower the pollutant or habitat impact.

For the department’s fish community assessments, 12 metrics are used with a total possible score of 60. For macroinvertebrate community assessments, eight metrics are used with a total possible score of 40. Where biological data are available, aquatic life use is then evaluated for each waterbody, based on the following scoring criteria.

Fully Supporting: Fish: 51-60
Macroinvertebrate: 30-40

Fully Supporting but Threatened: Fish: 31-50
Macroinvertebrate: 20-29

Partially Supporting: Fish: 21-30
Macroinvertebrate: 10-19

Not Supporting: Fish: 12-20
Macroinvertebrate: 0-9

Where biological community assessment information was available for both fish and macroinvertebrates and where aquatic life use assessments were different, the assessment decision resulting in the greatest impairment prevailed. In the same manner, where waterbody assessments based on chemical data conflicted with biological assessments, the biological assessment prevailed.

2. Recreation

Recreation use includes swimming, boating, wading, or any recreational activities which rely on water. Recreation use in rivers and streams is considered fully supporting when there is little or no risk of illness through contact with the water. Recreation use determinations were made using fecal coliform data collected between 1991 and 1995. Assessments were defined as monitored if data from a minimum of ten samples were collected from the waterbody during the assessment period 1991-1995. Assessments were considered evaluated if: 1) monitored data were collected prior to 1991, 2) less than ten samples were collected, and/or 3) the assessment was extrapolated from data collected either upstream or downstream from the waterbody. Evaluated assessments which meet the criteria for partially supporting recreational use were assessed as fully supporting but threatened. For each assessment based on fecal coliform data, the following criteria were used:

Criterion 1: The geometric mean of the samples should not exceed 200 colonies per 100 milliliters (mL).

Criterion 2: Not more than 10 percent of the samples should have a density exceeding 400 colonies per 100 mL.

The two criteria were then applied using the following use support decision criteria:

Fully Supporting: Both criteria 1 and 2 are met.

Fully Supporting but Threatened: Meets the decision criteria for partially supporting, based on evaluated data.

Partially Supporting: Criteria 1 or 2 are not met.

Not Supporting: Both Criteria 1 and 2 are not met.

3. Drinking Water Supply

Drinking water is defined as “waters that are suitable for use as a source of water supply for drinking and culinary purposes, after treatment to a level approved by the Department.” (*State Water Quality Standards*)

Drinking water use was assessed as monitored when chemical monitoring data were available and as evaluated when the assessment was based on the occurrence of taste and odor complaints. Monitored assessments were conducted by comparing chemical concentration data to the human health standards for Class I, IA, and II rivers and streams. The human health standard for Class I, IA, and II rivers and streams considers two means of exposure: 1) ingestion of contaminated aquatic organisms and 2) ingestion of contaminated drinking water. Therefore, any waterbody with contaminant levels exceeding the human health standard would be considered not fully supporting its drinking water use designation.

In order to make beneficial use determinations for drinking water, the following decision criteria were used:

Fully Supporting: For each human health contaminant, greater than 50 percent of the samples had concentrations lower than the water quality standard, and there are no drinking water complaints on record.

Fully Supporting but Threatened: For each contaminant, greater than 50 percent of the samples had concentrations lower than the standard; however, knowledge of taste and odor problems or increased treatment costs have been associated with pollutants.

Partially Supporting: For at least one contaminant, greater than 50 percent of the samples exceed the human health standard, and/or frequent taste and odor complaints are on record.

Not Supporting: Drinking water supply closure is on record within the period 1991-1995.

4. Fish Consumption

As stated previously, fish consumption is not a beneficial use specifically defined in *State Water Quality Standards*, but is implied through narrative and numeric human health criteria. Fish consumption use is defined as the eating of fish without health effects. For purposes of the state's fish consumption advisory and this analysis, a risk factor of 1 in 1 million is assumed.

The state's fish consumption advisory was used to make use support determinations for fish consumption. The advisory is based solely on human dietary exposure from fish containing mercury. The Health Department annually selects lakes, reservoirs, rivers, and streams in the state and monitors fish tissue mercury concentrations. To date, every waterbody sampled for mercury has been listed in the state's fish consumption advisory. There have been no consumption bans issued in North Dakota. In order to assess the fish consumption use, the following decision criteria were used. These criteria only apply to waterbodies for which fish tissue data and advisory information exist.

Fully Supporting: No consumption restrictions or bans were present during the reporting period.

Partially Supporting: A restricted consumption advisory exists for the general population and/or subpopulations.

Not Supporting: A consumption advisory ban exists for the general population and/or subpopulations.

Since every waterbody tested for mercury in fish tissue has been listed in North Dakota's fish consumption advisory and no consumption bans are present, use determinations fall into two categories: partially supporting and not assessed. Unassessed waterbodies have not been sampled and analyzed for mercury.

Beneficial Use Assessment Methodology for Lakes and Reservoirs

1. Aquatic Life and Recreation

Trophic status is the primary indicator used to assess beneficial uses in the state's lakes and reservoirs. Trophic status is the measure of productivity of a lake or reservoir as directly related to the level of nutrients (phosphorus and nitrogen) entering the lake or reservoir from its watershed. Highly productive lakes, termed "hypereutrophic," contain excessive phosphorus and are characterized by large growths of weeds, bluegreen algal blooms, and low DO concentrations. These lakes experience frequent fish kills and are generally characterized as having excessive rough fish populations (carp, bullhead, sucker) and poor sport fisheries. Due to the frequent algal blooms and excessive weed growth, these lakes are also undesirable for recreational uses such as swimming and boating.

Mesotrophic and eutrophic lakes, on the other hand, have lower phosphorus concentrations, low to moderate levels of aquatic plant growth, and good DO concentrations throughout the year. Mesotrophic lakes do not experience algal blooms, while eutrophic lakes may occasionally experience algal blooms of short duration, typically a few days to a week.

Due to this relationship between trophic status and the aquatic community (as reflected by the fishery), or between trophic status and the frequency of algal blooms, trophic status becomes an effective indicator of aquatic life use and recreation. It has been generally assumed, for purposes of this report, that hypereutrophic lakes only partially support a fishery and are limited in their recreational use; whereas mesotrophic lakes fully support both aquatic life use and recreation. Eutrophic lakes may be assessed as fully supporting, threatened, or partially supporting their uses for aquatic life or recreation. Eutrophic lakes are further assessed based on: 1) information provided by local water resource managers and the public, 2) the knowledge of land use in the lake's watershed, and/or 3) the relative degree of eutrophication.

For example, a eutrophic lake, which has a well-balanced sport fishery and experiences infrequent algal blooms, is assessed as fully supporting. A eutrophic lake, which experiences periodic algal blooms and limited swimming use, would be assessed as partially supporting recreation use. A lake fully supporting its aquatic life and/or recreation use but which, through monitoring, has shown a decline in its trophic status, (i.e., increasing phosphorus concentrations over time), would be assessed as fully supporting but threatened.

It is recognized that this assessment procedure ignores the fact that, through natural succession, some lakes and reservoirs may display naturally high phosphorus concentrations and experience high productivity. While natural succession or eutrophication can cause high phosphorus concentrations, recent research suggests that these lakes are typically eutrophic and that lakes classified as hypereutrophic are reflecting external nutrient loading in excess of that occurring naturally.

2. Drinking Water

All lakes and reservoirs classified in *State Water Quality Standards*, with the exception of Lake George in Kidder County, are assigned the drinking water beneficial use. While most lakes and reservoirs are assigned this use, few are currently used as a drinking water supply. Lake Sakakawea, a drinking water supply for the Southwest Water Pipeline and the cities of Garrison, Parshall, Pick City, and Riverdale, was assessed as fully supporting. All other lakes and reservoirs assigned the drinking water supply beneficial use were not assessed.

3. Fish Consumption

The fish consumption use for lakes and reservoirs was assessed in the same way as the procedure for rivers and streams.

Chapter 3. Rivers and Streams Water Quality Assessment

Statewide Assessment

Seventy-one percent (8460 miles) of the 11,928 miles of rivers and streams assessed for this report fully support the beneficial use designated as aquatic life (Table 11). Of the streams assessed as fully supporting aquatic life use, 87 percent (7364 miles) are considered threatened. In other words, if water quality trends continue, the stream may not fully support its use for aquatic life in the future. The remaining 29 percent of rivers and streams assessed for this report were either partially supporting or not supporting aquatic life use (Table 11).

For purposes of this report, aquatic life use support is described for wadable streams by the type of information used in the assessment methodology (biological and/or physical/chemical) (Table 12). Biological assessment information was used to assess 1640 miles of streams in the state, while physical/chemical data alone was used to assess 9583 miles. Forty-one percent of the wadable streams assessed as partially supporting or not supporting aquatic life use were assessed based in part on biological community assessment data.

NPS pollution (e.g., nutrient loading, siltation of the streambed, and stream habitat loss or degradation) was the primary cause of aquatic life use impairment (Table 13). Other forms of pollution causing impairment are trace element contamination, flow alteration, and organic enrichment. Organic enrichment creates conditions in the stream which cause DO to be depleted. Rivers and streams suffering from organic enrichment will display a shift in species composition from an aquatic community comprised of intolerant species (e.g., mayflies, caddisflies, stoneflies, darters) to an aquatic community dominated by tolerant species (e.g., midges, carp, bullheads).

The primary sources of pollutants affecting aquatic life use in the state are cropland erosion and runoff, confined animal feeding operations, wetland drainage, and poor grazing management (Table 14). Poor grazing management includes riparian grazing and season-long grazing, which result in the deterioration of the plant community or cause a shift in the plant community away from native grass and forb species to non-native invader species. Evidence of poor grazing practices would include cattle trailing, gully erosion, poor water infiltration rates resulting from soil compaction, and severe streambank erosion. Other sources linked to aquatic life use impairment are point source discharges, urban runoff, and stream channel/flow alteration (e.g., upstream impoundments, low-head dams, channelization, flow regulation and diversion, riparian vegetation removal). (Table 14).

Recreation use was assessed on 9000 miles of rivers and streams in the state. Recreation use was fully supporting, fully supporting but threatened, partially supporting, and not supporting on 1440 miles, 4565 miles, 2781 miles, and 214 miles, respectively. Fecal coliform bacteria data collected from monitoring stations across the state were the primary indicators of recreation use attainment (see Part III, Chapter 2. Assessment Methodology). For this reason, pathogens (as reflected by fecal coliform bacteria) are the primary cause of recreation use impairment in North Dakota (Table 13). Other factors affecting the use of our rivers and streams for recreation would be eutrophication from excessive nutrient loading, resulting in nuisance algae and plant growth. The primary sources of fecal coliform bacteria contamination in the state are confined animal feeding operations and riparian area grazing (Table 14). Point source discharges have also been linked to exceedances of

the fecal coliform bacteria standard of 200 colonies per 100 mL. These exceedances occur when a municipality discharges from its sanitary sewer directly to the receiving stream, bypassing the wastewater treatment facility. During the reporting period 1994-1995, these circumstances generally occurred in the spring when flooding problems caused infiltration to the sanitary sewer.

Drinking water supply use is classified for 5320 miles of rivers and streams in the state. Of the 687 miles assessed for this report, only 34.4 miles (5 percent) were assessed as partially supporting its use for drinking water supply (Table 11). The primary cause of use impairment are taste and odor problems (Table 13). While the source of taste and odor has not been specifically identified, potential sources include agricultural field runoff, reservoir releases, wetland drainage, and industrial and/or municipal discharges (Table 14).

A total of 5600 miles of rivers and streams were identified as capable of supporting a sport fishery from which fish could be used for consumption. Four-hundred-sixty miles of rivers and streams have been monitored for methyl-mercury in fish, resulting in consumption advisories. Rivers in the advisory include the Red River of the North, the Missouri River, and the Yellowstone River. These advisories form the basis for fish consumption use impairment in the state (Table 11). While there are many potential sources of methyl-mercury, both anthropogenic and natural, to date there have been no specific sources identified for the mercury present in North Dakota fish (Table 14).

Table 11. Individual Use Support Summary for Rivers and Streams in North Dakota (Miles)

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Supporting but Threatened</u>	<u>Partially Not Supporting</u>	<u>Not Supporting</u>	<u>Assessed</u>
Aquatic Life	1095.65	7423.25	3095.88	312.75	42061.87
Fish Consumption			460.43		5145.77
Recreation	1440.38	4564.78	2781.36	213.68	44989.20
Drinking Water Supply	154.07	498.21	34.40		4633.71

Table 12. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in North Dakota

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting	15.26	1028.27	52.12	1095.65
Fully Supporting but Threatened	135.40	6699.48	136.95	6971.83
Partially Supporting	637.65	1816.62	451.76	2906.03
Not Supporting	211.25	20.55		231.80

Table 13. Cause of Beneficial Use Impairment for Rivers and Streams in North Dakota

<u>Cause Categories</u>	<u>Major Impacts (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0200 Pesticides	0.00	5.53
0500 Metals	0.00	375.76
0510 Mercury	0.00	407.62
0600 Un-ionized Ammonia	0.00	33.54
0900 Nutrients	10.87	2958.03
1100 Siltation	137.68	2804.68
1200 Organic Enrichment/Low DO	6.99	752.48
1300 Salinity/TDS/Chlorides	0.00	122.74
1500 Flow Alteration	11.69	589.58
1600 Stream Habitat Degradation	558.78	2378.58
1700 Pathogens (Fecal Coliform Bacteria)	0.00	2265.60
2000 Taste and Odor	0.00	27.80
2200 Noxious Aquatic Plants	0.00	5.53

Table 14. Sources of Beneficial Use Impairment to Rivers and Streams in North Dakota

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0110 Major Industrial Point Source	0.00	36.09
0120 Minor Industrial Point Source	0.00	21.32
0210 Major Municipal Point Source	0.00	129.67
0220 Minor Municipal Point Source	0.00	157.08
1100 Nonirrigated Crop Production	460.62	2651.42
1200 Irrigated Crop Production	0.00	23.41
1400 Pasture Land	0.00	1141.52
1500 Range Land	0.00	312.96
1510 Riparian Grazing	124.82	2849.25
1640 Confined Animal Feeding Operations	13.73	3153.14
3100 Highway/Road/Bridge Construction	0.00	37.20
3200 Land Development	20.19	202.51
4000 Urban Runoff/Storm Sewers	17.86	361.62
5100 Surface Mining	0.00	29.89
5500 Petroleum Activities	0.00	48.56
6300 Landfills	0.00	5.53
7000 Hydrologic Modification	0.00	5.53
7050 Low Head Dams	0.00	241.60
7100 Channelization	127.75	291.61
7400 Flow Regulation/Modification	20.55	337.67
7600 Removal of Riparian Vegetation	68.45	240.89
7700 Streambank Modification	0.00	62.20
7800 Drainage/Filling of Wetlands	138.76	1436.69
8300 Highway Maintenance and Runoff	0.00	8.53
8500 Contaminated Sediments	5.53	0.00

Table 14. (cont.) Sources of Beneficial Use Impairment to Rivers and Streams in North Dakota

<u>Source Categories</u>	<u>Major Impact (miles)</u>	<u>Moderate/Minor Impact (miles)</u>
8600 Natural Sources	0.00	289.95
8710 Golf Course Management	0.00	14.68
8800 Upstream Impoundment	14.25	601.99
8900 Salt Storage Sites	0.00	5.00
8910 Ground Water Loadings	0.00	71.10
9000 Unknown Sources	0.00	475.55
9010 Migratory Waterfowl	0.00	65.20

Basin Assessments

In addition to the statewide water quality assessment previously described, water quality assessment information is available for each of the major river basins in the state (Figure 1). The following is a summary of beneficial use attainment and a description of the causes and sources of use impairment for the Souris River, Red River (including Devils Lake), Missouri River/Lake Sakakawea, Missouri River/Lake Oahe, and James River basins.

1. Souris River Basin

There are 3,645 river and stream miles in the Souris River basin. Forty-four percent (1600 miles) of the total river and stream miles in the basin were assessed for aquatic life use. Physical/chemical data alone were used to assess rivers and streams in the basin (Table 15). Of the 1600 miles assessed for aquatic life use, 29 percent (464 miles) fully supported aquatic life use, and 23 percent partially supported aquatic life use. The remaining 48 percent of assessed stream miles fully supported, but were threatened (Table 15, Figure 7).

The primary cause of aquatic life impairment in the Souris River basin is stream habitat degradation, such as channelization, snagging and clearing, and bank stabilization using rock riprap (Table 17). Other impairments to aquatic life use were nutrients (nitrogen and phosphorus), siltation, and stream flow alteration caused by management of upstream impoundments (Table 17).

Sources of nutrients in the basin include NPS runoff from cropland and urban areas, runoff from confined animal feeding operations, and riparian area grazing (Table 18). Sources of excessive stream sediment include runoff from poorly managed grazing lands, cropland, and urban areas. Another source, stream bank erosion, can be caused by excessive grazing pressure, poor riparian forest management, and stream bank encroachment and riparian area loss from land development (Table 18).

Recreation use was assessed on 33.5 percent (1222 miles) of rivers and streams in the Souris River basin, with 39 percent (477 miles) fully supporting its use for recreation (Table 15, Figure 8). An additional 52 percent (639 miles) of rivers and streams assessed for this report were categorized as

Figure 7. Aquatic Life Use Support in the Souris River Basin

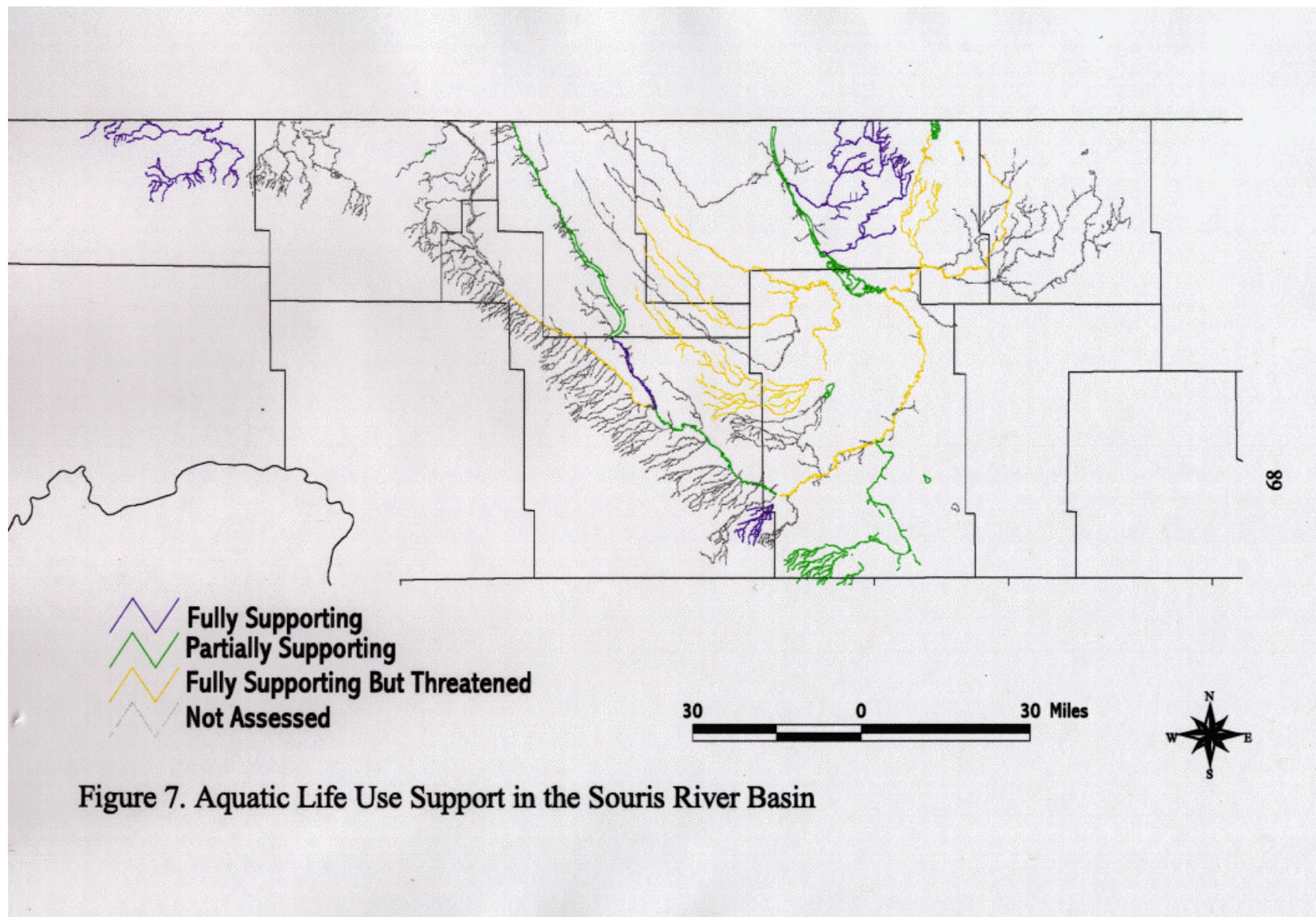
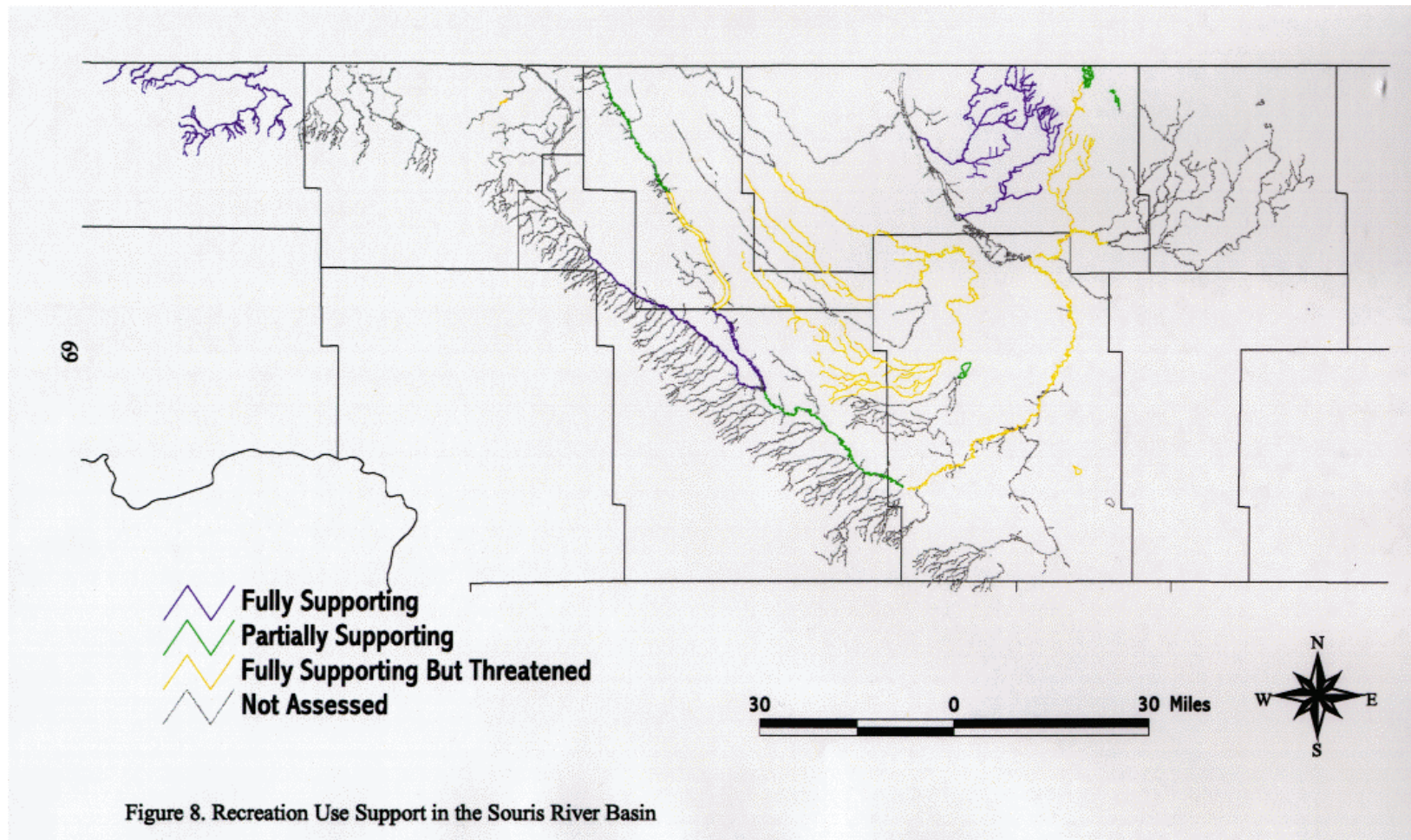


Figure 7. Aquatic Life Use Support in the Souris River Basin

Figure 8. Recreation Use Support in the Souris River Basin



fully supporting, but threatened. Only 8.6 percent (106 miles) of assessed river and stream miles partially supported recreation use.

Pathogens, as indicated by fecal coliform bacteria, are the cause of recreation use impairment (Table 17). The sources of fecal coliform bacteria pollution, as is the case statewide, are confined animal feeding operations and riparian grazing. Point source contributions were not identified as a source of pathogen contamination in the Souris River basin.

The Souris River, the Des Lacs River, and Willow Creek are the only rivers and streams in the Souris River basin classified for drinking water supply use. Of the 410 miles classified for drinking water supply use, 65 miles were assessed as fully supporting, but threatened (Table 15).

Table 15. Individual Use Support Summary for Rivers and Streams in the Souris River Basin

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Support- ing but Threatened</u>	<u>Partially Not Supporting</u>	<u>Assessed</u>
Aquatic Life	464.10	769.20	366.70	2045.00
Fish Consumption				625.20
Recreation	477.00	639.40	105.60	2423.00
Drinking Water Supply		65.20		345.00

Table 16. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in the Souris River Basin

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C Data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting	00.0	464.10	00.0	464.10
Fully Supporting, but Threatened	00.0	769.20	00.0	769.20
Partially Supporting	00.0	366.70	00.0	366.70
Not Supporting	00.0	00.0	00.0	0.00

Table 17. Causes of Beneficial Use Impairment to Rivers and Streams in the Souris River Basin

<u>Cause Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0500 Metals	0.00	170.80
0900 Nutrients	0.00	323.30
1100 Siltation	0.00	258.10
1200 Organic Enrichment/Low DO	0.00	195.90
1500 Flow Alteration	0.00	222.50
1600 Stream Habitat Degradation	0.00	418.40
1700 Pathogens (Fecal Coliform Bac.)	0.00	105.60

Table 18. Sources of Beneficial Use Impairment to Rivers and Streams in the Souris River Basin

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0110 Major Municipal Point Source	0.00	27.04
1100 Nonirrigated Crop Production	0.00	304.50
1510 Riparian Grazing	0.00	290.20
1640 Confined Animal Feeding Operations	0.00	291.00
3200 Land Development	0.00	62.20
4000 Urban Runoff / Storm Sewers	0.00	113.90
7100 Channelization	65.20	24.47
7400 Flow Regulation/Modification	0.00	255.30
7600 Removal of Riparian Vegetation	0.00	62.20
7700 Streambank Modification	0.00	62.20
8800 Upstream Impoundment	0.00	171.30
8900 Salt Storage Sites	0.00	5.00
9000 Unknown Sources	0.00	108.60
9010 Migratory Waterfowl	0.00	65.20

2. Red River Basin

Based on the Reach File 3 river file, there are an estimated 11,795 river and stream miles in the Red River Basin. These estimates also include river and stream miles in the Devils Lake subbasin. Aquatic life use was assessed in the Red River basin through a combination of physical, chemical, and/or biological monitoring data (Table 19). Biological assessments (fish and/or macroinvertebrates) comprised 42 percent (3259 miles) of rivers and streams assessed for aquatic life (Table 19). Of the 3259 river and stream miles assessed for aquatic life use attainment in the Red River basin, 52 percent (1698 miles) fully support aquatic life use. The remaining 48 percent (1562 miles) either partially support or do not support aquatic life use. Seventy-seven percent of the river and stream miles assessed as partially supporting or not supporting aquatic life use were assessed

using biological monitoring data.

The primary pollutants causing aquatic life use impairment in the Red River basin are silt, nutrients, and organic material (Table 21). Sources of the pollutants are cropland erosion and runoff and wetland drainage. Other sources of nutrients include riparian area grazing and unregulated confined livestock feeding operations (Table 22). Stream habitat degradation and stream flow alteration are other significant causes of aquatic life use impairment in the basin (Table 21). Stream habitat degradation can be caused by riparian area grazing, low head dams, channelization, and excessive snagging and clearing. Stream flow can be altered by upstream reservoir management and the appropriation of water for other uses (e.g., irrigation, municipal water supply, industrial water supply).

Thirteen percent (1564 miles) of the rivers and streams in the Red River basin were assessed for recreation use support, with 985 miles fully supporting this use. Of the 985 mile fully supporting recreation use, 79 percent (777 miles) were threatened. The remaining 579 miles were partially supporting or not supporting the recreation use designation (Table 19).

Pathogens, as indicated by fecal coliform bacteria, are the primary cause of recreation use impairment. Sources of elevated fecal coliform bacteria concentrations in the Red River basin are confined livestock feeding operations, riparian area grazing, and urban runoff. To a lesser extent, municipal sewer bypasses also contribute to fecal coliform bacteria contamination in the basin.

Drinking water supply use is classified for 2081 miles of rivers and streams in the basin. Drinking water supply use was assessed for 526 miles of stream, with 93 percent (985 miles) of those streams fully supporting drinking water use. Thirty-four miles of river were assessed as partially supporting drinking water use. This assessment is based on taste and odor complaints and the occurrence of periodic exceedences of both the chloride and sulfate standards within that reach of the Red River at Fargo. While specific sources of taste and odor have not been identified, potential sources include agricultural runoff, upstream reservoir releases, wetland drainage, industrial discharges, and municipal discharges. Elevated sulfate and chloride concentrations in the Red River have been related to late winter or summer low flow releases from Mud Lake/Lake Traverse.

A fish consumption advisory is in place for two reaches of the Red River, from Wahpeton downstream to Grand Forks and from Drayton downstream to Pembina (Table 19). The advisory is based on elevated methyl-mercury concentrations in channel catfish, northern pike, and walleye. As a result of the advisory information for the Red River, 314 miles of river in the basin were assessed as partially supporting for fish consumption use (Table 19). Sources of methyl-mercury in fish are largely unknown, but are likely both anthropogenic and natural.

Table 19. Individual Use Support Summary for Rivers and Streams in the Red River Basin, Including Devils Lake

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Supporting but Threatened</u>	<u>Partially Not Supporting</u>	<u>Not Supporting</u>	<u>Assessed</u>
Aquatic Life	15.26	1682.35	1248.79	312.75	8535.62
Fish Consumption			313.74		1806.88
Recreation	207.97	776.65	558.72	20.55	10230.88
Drinking Water Supply	58.54	433.01	34.40		1554.72

Table 20. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in the Red River Basin, Including Devils Lake

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C Data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting	15.26			15.26
Fully Supporting but Threatened	92.83	1391.77	83.69	1568.29
Partially Supporting	594.35	334.63	385.33	1314.31
Not Supporting	211.25	20.55		231.80

Table 21. Causes of Beneficial Use Impairment to Rivers and Streams in the Red River Basin, Including Devils Lake

<u>Cause Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0200 Pesticides	0.00	5.53
0500 Metals	0.00	80.95
0510 Mercury	0.00	275.46
0600 Un-ionized Ammonia	0.00	31.54
0900 Nutrients	10.87	1376.84
1100 Siltation	137.86	1294.08
1200 Organic Enrichment/Low DO	6.99	399.09
1300 Salinity/TDS/Chlorides	0.00	71.10
1500 Flow Alteration	11.69	285.70
1600 Stream Habitat Degradation	507.78	1014.06
1700 Pathogens (Fecal Coliform Bac.)	0.00	417.84
2000 Taste and Odor	0.00	27.80
2200 Noxious Aquatic Plants	0.00	5.53

Table 22. Sources of Beneficial Use Impairment to Rivers and Streams in the Red River Basin, Including Devils Lake

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0110 Major Industrial Point Source	0.00	36.09
0210 Major Municipal Point Source	0.00	66.22
0220 Minor Municipal Point Source	0.00	82.64
1100 Nonirrigated Crop Production	460.62	1056.28
1400 Pasture Land	0.00	361.18
1510 Riparian Grazing	87.14	989.94
1640 Confined Animal Feeding Operations	0.00	521.89
3100 Highway/Road/Bridge Construction	0.00	5.53
3200 Land Development	18.71	76.38
4000 Urban Runoff / Storm Sewers	12.86	174.98
6300 Landfills	0.00	5.53
7000 Hydrologic Modification	0.00	5.53
7050 Low Head Dams	0.00	241.60
7100 Channelization	50.76	233.57
7400 Flow Regulation/Modification	20.55	57.67
7600 Removal of Riparian Vegetation	66.97	178.69
7800 Drainage/Filling of Wetlands	138.76	1293.63
8300 Highway Maintenance and Runoff	0.00	8.53
8500 Contaminated Sediments	5.53	0.00
8600 Natural Sources	0.00	58.35
8710 Golf Course Management	0.00	14.68
8800 Upstream Impoundment	12.77	306.60
8910 Ground Water Loadings	0.00	71.10
9000 Unknown Sources	0.00	187.13

3. Missouri River/Lake Sakakwea Basin

Approximately 66 percent of the state's river and stream miles are within the Missouri River basin, with over 25 percent (13,866 miles) in the Lake Sakakawea subbasin. While a significant portion of the state's rivers and streams are found within this subbasin, little more than 10 percent (1515 miles) were assessed for this report. The lack of quality assessment information for rivers and streams in this basin, relative to other basins in the state, is due in part to the large geographic area which encompasses this basin, limited site access (much of this basin is remote with few roads), the hydrology of the basin (most of the stream miles are represented by intermittent and ephemeral streams), and other statewide priorities. It is the intention of the department to bridge this data gap through strategic, basin-wide sampling using a combination of chemical, physical, and biological monitoring methods. According to the department's water quality assessment strategic plan, the Lake Sakakawea basin is scheduled for intensive basin-wide monitoring and assessment in the year 2000.

Of the 1515 river and stream miles assessed for aquatic life use, 12.5 percent (189 miles) were assessed as partially supporting. This assessment was primarily the result of chemical monitoring data which showed elevated trace element (e.g., chromium, copper, arsenic) concentrations exceeding the acute and/or chronic criteria (Table 23). Most of these exceedences were observed from monitoring stations on the Little Missouri River and are believed to be the result of natural sources, compounded by anthropogenic activities such as oil exploration and drilling. The Little Missouri River drains an area known as the Little Missouri Badlands (Badlands). The Badlands are a rugged, deeply eroded area, which is well drained through a system of integrated drainages. Soils in this area are mostly regosols and lithosols derived from cretaceous shale deposits. These soils and the underlying substrate are believed to contain naturally high concentrations of trace elements. Through natural erosion processes in the area, sediment with these high trace element concentrations are suspended in the river, contributing to the observed concentrations found in water samples collected from the Little Missouri River and its tributaries. Activities in the watershed, such as oil exploration and road construction, cause additional erosion which contributes to the sediment and trace element load to the river.

Recreation use support was assessed on 10 percent (1380 miles) of the river and stream miles in the basin. Recreation use was fully supported or fully supported but threatened on 638 miles of river and streams in the basin. Recreation use was partially supported on 548 miles of river and streams and not supported on 193 miles (Table 23). Pathogens (i.e., fecal coliform bacteria) are the cause of recreation use impairment, with riparian grazing and confined animal feeding areas the major sources of bacterial contamination (Tables 25 and 26).

Fifty-one river miles were assessed as partially supporting fish consumption use (Table 23). River miles categorized as partially supporting are the Missouri River upstream from Lake Sakakawea, and the Yellowstone River upstream from its confluence with the Missouri River to the North Dakota-Montana border. In both instances, fish consumption use was assessed as partially supporting due to a fish consumption advisory for paddlefish. Methyl-mercury was present in detectable concentrations in paddlefish collected from both the Missouri and Yellowstone Rivers, necessitating the consumption advisory. As is the case with other areas of the state, the source of the mercury contamination is largely unknown.

Table 23. Individual Use Support Summary for Rivers and Streams in the Missouri River/Lake Sakakawea Basin

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Supporting but Threatened</u>	<u>Partially Not Supporting</u>	<u>Not Supporting</u>	<u>Assessed</u>
Aquatic Life	32.18	1294.76	188.52		12351.40
Fish Consumption			51.16		505.58
Recreation	134.54	503.91	548.39	193.13	12486.89
Drinking Water Supply					556.74

Table 24. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in the Missouri River/Lake Sakakawea Basin

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C Data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting		32.18		32.18
Fully Supporting but Threatened		1353.70		1353.70
Partially Supporting		107.96		107.96
Not Supporting				

Table 25. Causes of Beneficial Use Impairment for Rivers and Streams in the Missouri River/Lake Sakakawea Basin

<u>Cause Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0500 Metals	0.00	102.96
0510 Mercury	0.00	51.16
0900 Nutrients	10.87	9.89
1300 Salinity/TDS/Chlorides	0.00	5.00
1600 Stream Habitat Degradation	0.00	5.00
1700 Pathogens (Fecal Coliform Bacteria)	0.00	682.51

Table 26. Sources of Beneficial Use Impairment to Rivers and Streams in the Missouri River/Lake Sakakawea Basin

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0220 Minor Municipal Point Source	0.00	5.00
1100 Nonirrigated Crop Production	0.00	26.62
1200 Irrigated Crop Production	0.00	21.62
1510 Riparian Grazing	0.00	538.04
1640 Confined Animal Feeding Operations	0.00	719.83
5500 Petroleum Activities	0.00	33.68
7100 Channelization	0.00	5.00
8600 Natural Sources	0.00	203.36
8900 Salt Storage Sites	0.00	5.00
9000 Unknown Sources	0.00	98.82

4. Missouri River/Lake Oahe Basin

Forty-one percent (21,930 miles) of the state's river and stream miles are located in the Missouri River/Lake Oahe basin. This basin is also significant because it contains a 95-mile contiguous reach of Missouri River stretching from the Garrison Dam to Lake Oahe.

Aquatic life use was assessed on 22 percent (4803 miles) of rivers and streams in the basin (Table 27). The majority of these assessments were based on chemical monitoring data collected from stations located throughout the basin. Two-hundred fourteen miles of streams (Table 27) located in the Knife River watershed, were assessed, in part, on biological assessment data provided by North Dakota State University. Aquatic life use was assessed as partially supporting for 1042 miles of rivers and streams in the basin and fully supporting/fully supporting but threatened for 3761 miles.

Excessive nutrient loading, siltation, and sediment deposition within the stream channel; and stream habitat degradation are the primary pollutants causing aquatic life use impairment (Table 29). Sources of pollutants contributing to aquatic life use impairment in the Missouri River/Lake Oahe basin are confined animal feeding operations, riparian grazing, cropland erosion and runoff, and improper pasture and range land grazing (Table 30).

Recreation use was assessed on 4009 miles of rivers and streams in the basin. Thirty-three percent of the river and stream miles assessed for this report partially supported recreation use, while 58 percent were assessed as fully supporting but threatened (Table 27). Geometric mean fecal coliform bacteria concentrations in excess of the state standard of 200 colonies/100 mL were used as the indicator of pathogen contamination and recreation use impairment for this report (Table 29). Major sources of bacteria contamination in the basin are confined animal feeding operations and riparian area grazing along rivers and streams (Table 30).

The 95-mile reach of the Missouri River from Garrison Dam to Lake Oahe was assessed as partially supporting fish consumption use (Table 27). This assessment is based on fish consumption advisory information which suggests that health-sensitive persons (e.g., women who are pregnant, women

who plan to become pregnant, women who are breastfeeding, and children under the age of 7) limit their consumption of channel catfish, northern pike, sauger, or walleye to two meals per month. This consumption advisory is based on elevated methyl-mercury concentrations in fish (Table 29).

Drinking water supply was assessed as fully supporting for the Missouri River (Table 27). The remaining 1609 river and stream miles classified for drinking water supply use were not assessed for this report.

Table 27. Individual Use Support Summary for Rivers and Streams in the Missouri River/Lake Oahe Basin

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Supporting but Threatened</u>	<u>Partially Not Supporting</u>	<u>Assessed</u>
Aquatic Life	350.23	3410.92	1041.56	17127.41
Fish Consumption			95.53	1602.36
Recreation	359.88	2316.72	1332.46	17921.06
Drinking Water Supply	95.53			1609.45

Table 28. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in the Missouri River/Lake Oahe Basin

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C Data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting		253.61	52.12	305.73
Fully Supporting but Threatened	42.57	3282.22	53.26	3378.05
Partially Supporting	43.30	950.53	23.03	1016.86

Table 29. Causes of Beneficial Use Impairment for Rivers and Streams in the Missouri River/Lake Oahe Basin

<u>Cause Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0500 Metals	0.00	15.78
0510 Mercury	0.00	95.53
0600 Unionized Ammonia	0.00	2.00
0900 Nutrients	0.00	954.59
1100 Siltation	0.00	964.36
1200 Organic Enrichment/Low DO	0.00	122.93
1300 Salinity/TDS/Chlorides	0.00	46.64
1500 Flow Alteration	0.00	65.49
1600 Stream Habitat Degradation	49.52	870.34
1700 Pathogens (Fecal Coliform Bacteria)	0.00	1353.62

Table 30. Sources of Beneficial Use Impairment to Rivers and Streams in the Missouri River/Lake Oahe Basin

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0120 Minor Industrial Point Source	0.00	21.32
0210 Major Municipal Point Source	0.00	22.00
0220 Minor Municipal Point Source	0.00	64.55
1100 Nonirrigated Crop Production	0.00	960.61
1200 Irrigated Crop Production	0.00	1.79
1400 Pasture Land	0.00	492.20
1500 Range Land	0.00	312.96
1510 Riparian Grazing	37.68	929.31
1640 Confined Animal Feeding Operations	13.73	1402.50
3100 Highway/Road/Bridge Construction	0.00	15.78
3200 Land Development	0.00	49.52
4000 Urban Runoff / Storm Sewers	5.00	56.85
5100 Surface Mining	0.00	29.89
5500 Petroleum Activities	0.00	14.88
7100 Channelization	11.79	28.57
7400 Flow Regulation/Modification	0.00	24.70
8600 Natural Sources	0.00	28.24
8800 Upstream Impoundment	0.00	104.41
9000 Unknown Sources	0.00	81.00

5. James River Basin

Aquatic life and recreation uses were assessed on 26 percent of the river and stream miles in the James River basin. Fish consumption and drinking water supply use were not assessed.

Of the 750 river and stream miles assessed for aquatic life use in the James River basin, 55 percent (415 miles) were fully supporting or were fully supporting but threatened. The remaining 45 percent (309 miles) were partially supporting aquatic life use (Table 31). Siltation, nutrient loading, and stream habitat degradation were the major pollutant causes of impairment to the biological community (Table 33). Sources of these pollutants were assessed as cropland erosion and runoff, confined animal feeding operations, wetland drainage, and poor grazing management (Table 34). Poor grazing management occurs in both upland pastures and along riparian areas, resulting in poor vegetative health and degraded pasture condition.

Recreation use was assessed for 747 miles of river and streams in the basin (Table 31). Fecal coliform bacteria data collected in the basin indicated partial use support on 158 miles, while recreation use was fully supporting and fully supporting but threatened on 261 and 328 miles, respectively (Table 31). Riparian area grazing and confined animal feeding areas are the primary sources of fecal coliform bacteria contamination in the James River basin (Table 34).

Table 31. Individual Use Support Summary for Rivers and Streams in the James River Basin

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Support- ing but Threatened</u>	<u>Partially Not Supporting</u>	<u>Assessed</u>
Aquatic Life	233.88	207.08	309.25	2002.44
Fish Consumption				567.80
Recreation	260.99	328.10	157.94	2005.62
Drinking Water Supply				567.80

Table 32. Summary of Aquatic Life Use Support by Assessment Methodology for Wadable Streams in the James River Basin

<u>Degree of ALUS</u>	<u>Miles Assessed Based on B/H Data Only</u>	<u>Miles Assessed Based on P/C Data Only</u>	<u>Miles Assessed Based on B/H and P/C Data</u>	<u>Total Miles Assessed for ALUS</u>
Fully Supporting		233.88		233.88
Fully Supporting, but Threatened		207.08		207.08
Partially Supporting		309.25		309.25

Table 33. Causes of Beneficial Use Impairment for Rivers and Streams in the James River Basin

<u>Cause Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0500 Metals	0.00	5.27
0900 Nutrients	0.00	293.41
1100 Siltation	0.00	288.14
1200 Organic Enrichment/Low DO	0.00	34.56
1500 Flow Alteration	0.00	15.89
1600 Stream Habitat Degradation	1.48	289.15
1700 Pathogens (Fecal Coliform Bacteria)	0.00	156.46

Table 34. Sources of Beneficial Use Impairment to Rivers and Streams in the James River Basin

<u>Source Categories</u>	<u>Major Impact (Miles)</u>	<u>Moderate/Minor Impact (Miles)</u>
0210 Major Municipal Point Source	0.00	14.41
1100 Nonirrigated Crop Production	0.00	303.41
1400 Pasture Land	0.00	288.14
1510 Riparian Grazing	37.68	298.14
1640 Confined Animal Feeding Operations	13.73	288.14
3100 Highway/Road/Bridge Construction	0.00	15.89
3200 Land Development	1.48	14.41
4000 Urban Runoff / Storm Sewers	0.00	15.89
7600 Removal of Riparian Vegetation	1.48	0.00
7800 Drainage/Filling of Wetlands	0.00	143.06
8800 Upstream Impoundment	1.48	19.68

Chapter 4. Lakes Water Quality Assessment

Statewide Assessment

From 1987 until the spring of 1993, North Dakota lakes and reservoirs were severely impacted by drought. Flooding replaced drought as the greatest impact beginning in April of 1993 and continuing through 1995. While flooding continues to be a significant problem in many areas of the state, the southwest and northwest regions have received normal to below normal precipitation for the last two years.

One of the most apparent effects of the increased precipitation and resulting runoff was the filling of nearly all reservoirs and lakes during a three-month period in the spring and early summer of 1993. Devils Lake provides the most dramatic example of the change in precipitation resulting in an increase in lake depth and area. In the fall of 1992, Devils Lake had declined to an elevation of 1422.5 feet msl with a surface area of approximately 52,000 acres. By the fall of 1993, the lake had risen over 5 feet to an elevation of 1427.7 feet msl and increased in size to 58,715 acres. By the fall of 1995, Devils Lake had risen an additional 7.4 feet to an elevation of 1435.1 msl and increased its surface area to approximately 74,500 acres.

A total of 116 lakes and reservoirs (42 natural lakes and 74 reservoirs), representing 631,228 surface acres, were assessed for this report (Table 35). The remaining 103 lakes and reservoirs not assessed represent 19,152 acres or less than 3 percent of the total lake and reservoir acres in the state.

For purposes of this report, the term “aquatic life use” is synonymous with biological integrity and is defined as the ability of a lake or reservoir to support and maintain a balanced, adaptive community of aquatic organisms (e.g., fish, zooplankton, phytoplankton, macroinvertebrates, vascular plants) having a species composition, diversity, and functional organization comparable to that of least impaired reference lakes and reservoirs in the region (modified from Karr et al., 1981). Sixty-five lakes and reservoirs representing 600,619 acres were assessed as fully supporting aquatic life use (Table 35); in other words, they are considered capable of supporting and maintaining a balanced community of aquatic organisms. Of this total, 51 lakes and reservoirs representing 460,177 acres are considered threatened (Table 35). A threatened assessment means that if water quality and/or watershed trends continue, it is unlikely these lakes will continue to support aquatic life use. The lakes and reservoirs will begin to experience more frequent algal blooms and fish kills. They will display a shift in trophic status from a mesotrophic or eutrophic condition to a hypereutrophic condition.

Fifty lakes and reservoirs, totaling 24,609 surface acres, were assessed as partially supporting aquatic life use (Table 35). One of the primary causes of aquatic life impairment to the state’s lakes and reservoirs is low DO in the water column (Table 36). Low DO in lakes can occur in summer (referred to as summer kills), but usually occurs in the winter under ice cover conditions. Low DO conditions and winter kills occur when senescent plants and algae decompose, consuming available oxygen. Because the lake is ice-covered, reaeration is minimal, and the lake goes anoxic resulting in a fish kill. While fish kills are the most apparent impact affecting sensitive fish species (e.g., walleye, trout, bass, bluegill, crappie, northern pike), other DO-sensitive aquatic organisms may also be affected. When fish kills occur, low DO-tolerant fish species (e.g., carp, bullhead, white suckers)

will be favored, resulting in a lake dominated by these “rough” fish species.

Pollutants which stimulate the production of organic matter, such as plants and algae, can also cause aquatic life impairment. Two such secondary pollutant causes are excessive nutrient loading and siltation (Table 36).

Major sources of nutrient loading to the state's lakes and reservoirs are erosion and runoff from cropland, runoff from concentrated livestock feeding and wintering operations, and wetland drainage (Table 37). Wetland drainage, channelization, and ditching increase the runoff and delivery rates to lakes and reservoirs, in effect, increasing the size of a lake's watershed. Nutrients, sediment, and organic matter, which would be retained in wetlands under normal conditions, become part of the lake's external budget. Other sources of nutrient loading which affect lakes in the state are point source discharges from municipal wastewater treatment facilities, urban/stormwater runoff, and shoreline development (Table 37).

Municipal point sources have been linked to nutrient loading in 9,857 lake and reservoir acres in the state. The impacts are nearly all considered minor. Of special interest is Lake Darling, a 9,460-acre reservoir and national wildlife refuge, which is impacted by point source releases in Saskatchewan, Canada.

Shoreline or cabin development directly contributes nutrients to lakes in many ways. Typically, lake cabins or homes use septic systems (tanks and drain fields) to contain their wastewater. Many of these systems are poorly designed, poorly maintained, or nonexistent. Poorly designed septic systems provide a direct path of nutrients from the cabin to the lake. In addition, cabins or homes along lakes can contribute nutrients through fertilizer runoff from lawns.

Shoreline development can indirectly lead to increased nutrient loading when development results in a loss of the natural vegetation surrounding the lake. This buffer, between the lake and its watershed, provides for the assimilation of nutrients and retention of sediments contained in the runoff from the surrounding landscape. When this buffer is lost or degraded due to development, nutrients, sediment, and other chemicals (e.g., pesticides, road salts) are afforded a direct path to the lake.

The previously mentioned sources are considered external or watershed-scale sources of nutrient loading. Another source which at times can represent a significant portion of the nutrient budget is internal cycling, particularly in those lakes which periodically go anoxic either during ice cover or through thermal stratification in the summer. Under these circumstances, phosphorus and reduced forms of nitrogen (e.g., ammonia) can be released into the water column. The increased nutrient concentrations impair use by stimulating noxious weed growth and algal blooms.

Recreation use (e.g., swimming, waterskiing, boating, sailing, sunbathing) was assessed for 625,591 lake and reservoir acres in the state. Of this total, 51 lakes, representing 99,474 acres, were assessed as partially supporting use for recreation (Table 35). The primary cause of use impairment is excessive nutrient loading, which results in nuisance algal blooms and noxious aquatic plant growth (Table 36). Sources of nutrients causing algal blooms and weed growth were described in the previous section on aquatic life use (Table 37). Fifty lakes totaling 391,010 acres were assessed as

threatened (Table 35). Nutrient loading is also linked to the negative water quality trends these lakes are experiencing. If left unchecked, these lakes will degrade to the point where frequent algal blooms and/or excessive weed growth will negatively affect recreation.

Two-hundred-fifteen lakes and reservoirs, representing 643,085 acres, were assigned the use for fish consumption (Table 35). Lakes not assigned the fish consumption use are saline lakes which cannot support a sport fishery. These lakes are also not assigned the use for municipal drinking water supply.

Of the 215 lakes entered into the WBS and assigned the use for fish consumption, 33 lakes and reservoirs, totaling 494,389 acres, were considered partially supporting fish consumption use (Table 35). The remaining 182 lakes and reservoirs which support a sport fishery were not assessed for this report. The 33 lakes and reservoirs assessed as partially supporting fish consumption use were so designated because each one has a fish consumption advisory. The advisory for each lake limits the consumption of fish due to methyl-mercury (Table 36).

Sources of methyl-mercury in fish remain largely unknown (Table 36). Potential sources of mercury include natural sources, atmospheric deposition, and runoff from cropland containing grain that was treated with a mercury-based fungicide (Note: The use of these fungicides is now prohibited.). Results of a draft report being prepared by the Health Department show an increase in mercury concentrations in the fillets of walleye, northern pike, and chinook salmon in Lake Sakakawea following the drought and recent filling of lake. One possible reason for the higher mercury concentrations in fish is that the lake may be experiencing an increase in the rate of mercury methylization due to greater amounts of organic matter in the lake following flooding. The drought of the late 1980s and early 1990s lowered the lake level, allowing vast areas of dry lake bed to revegetate. When the lake refilled beginning in 1993, the vegetation was flooded and began decomposing. The organic matter provided to the lake during this period is thought to have favored the methylization process. This is a microbial process where bacteria present in the lake convert elemental mercury to its more bioavailable methyl-mercury form. The increase in bioavailable mercury in the lake is reflected in higher mercury concentrations in fish.

Four reservoirs (Lake Sakakawea, Homme Dam, Bisbee Dam, and Mt. Carmel Reservoir) are currently used either directly or indirectly as municipal drinking water supplies, while two others (Patterson Lake and Renwick Dam) serve as back-up water supplies in the event the primary water supplies should fail.

Mt. Carmel Reservoir, Lake Sakakawea, and Homme Dam were assessed as fully supporting use for drinking water supply (Table 35). The remaining reservoirs were assessed as partially supporting use for drinking water supply. The primary causes of partial use support are frequent algal blooms stimulated by excessive nutrient loading and siltation (Table 36). Algal blooms affect the taste and odor of a drinking water supply and increase treatment costs. Siltation decreases reservoir volume, thereby reducing reservoir storage capacity as a drinking water supply. Agricultural runoff from cropland and concentrated animal feeding operations are the primary sources of nutrients and sediment to reservoirs partially supporting drinking water supply use (Table 37). Poor grazing management of pasture land, range land, and along riparian areas is also a significant source of sediment to water supply lakes and reservoirs (Table 37). In particular, riparian area grazing

destroys streambank vegetation, creating bank erosion which can be a significant source of sediment to lake and reservoirs.

Table 35. Individual Use Support Summary for North Dakota Lakes and Reservoirs in North Dakota

<u>Use</u>	<u>Fully Supporting</u>	<u>Fully Supporting but Threatened</u>	<u>Partially Not Supporting</u>	<u>Assessed</u>
Aquatic Life	146441.6	460177.0	24609.1	19152.3
Fish Consumption	0.0	0.0	494388.8	148695.9
Recreation	135106.4	391010.4	99473.9	24789.3
Drinking Water Supply	368762.0	0.0	1637.0	272685.7

Table 36. Causes of Beneficial Use Impairment for Lakes and Reservoirs in North Dakota

<u>Cause Categories</u>	<u>Major Impact (Acres)</u>	<u>Moderate/Minor Impact (Acres)</u>
0510 Mercury	0.0	494388.8
0900 Nutrients	106104.1	9335.2
1100 Siltation	17421.8	86829.0
1200 Organic enrichment/ Low DO	20338.9	16620.1
1300 Salinity/TDS/Chlorides	0.0	104.0
2200 Noxious Aquatic Plants	10.0	0.0
2500 Turbidity	2011.0	1686.0

Table 37. Sources of Beneficial Use Impairment for Lakes and Reservoirs in North Dakota

<u>Source Categories</u>	<u>Major Impact (Acres)</u>	<u>Moderate/Minor Impact (Acres)</u>
0220 Minor Municipal Point Sources	152.0	9705.1
1100 Nonirrigated Crop Production	107396.4	7437.9
1200 Irrigated Crop Production	31.8	0.0
1400 Pasture Land	9495.0	92747.3
1500 Range Land	12886.8	18036.5
1550 Livestock Degradation to Riparian Zone	9460.1	1219.8
1650 Concentrated Livestock Feeding/ Wintering Operations	29471.3	7529.6
2200 Forest Management	575.0	2852.0
4300 Urban Runoff/Storm Sewers	108.0	307.0
4350 Lake Shore Development	5279.7	961.5
5100 Surface Mining	0.0	260.5
7600 Removal of Riparian Vegetation	5098.0	0.0
7700 Streambank Modification/Destabilization	0.0	495.0
7750 Shoreline Erosion	0.0	1997.0
7800 Drainage/Filling of Wetlands	5510.0	77643.5
8600 Natural Sources	74500.0	1913.5
8700 Recreational Activities	0.0	1618.7
9000 Unknown Sources	0.0	476425.2
9030 Carp Bioturbation	0.0	2245.0

Trophic Status

Reservoirs and natural lakes were only assessed for trophic status if appropriate data were available. For purposes of this report, “trophic status” refers to the present condition or measure of eutrophication of the waterbody at the time of the assessment.

Accurate trophic status assessments are essential to making sound management decisions. In order to minimize errors in classification, all existing chemical, physical, quantitative, and qualitative data were used in making final trophic status assessments.

Because there are no trophic status indices specific to North Dakota waters, Carlson’s Trophic Status Index (TSI) (Carlson, R. E. 1977, “A Trophic State Index for Lakes,” *Limnology and Oceanography*, 22(2):361-369) was chosen as the initial method to describe a lake’s or reservoir’s trophic status. Carlson’s TSI was selected because it is commonly used by limnologists and because it was developed for Minnesota, a state close to North Dakota geographically (see section on LWQA Project on page 40).

An attempt was made to gather enough chemical and ancillary data to group as many of North Dakota’s 219 lakes/reservoirs into one of four trophic states (Table 38). The four trophic states, in order of increasing productivity, are oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Adequate data was available to assess the trophic status of 123 of the 219 lakes entered into the

WBS database. The majority of the state's assessed lakes and reservoirs range from eutrophic to hypereutrophic. Twenty lakes and reservoirs were assessed as mesotrophic. There were no oligotrophic lakes assessed in the state.

Table 38. Trophic Status of Lakes and Reservoirs in North Dakota

<u>Trophic Status</u>	<u>Number of Lakes</u>	<u>Acreage of Lakes</u>
Oligotrophic	0	0.00
Mesotrophic	20	503386.00
Eutrophic	49	19151.90
Hypereutrophic	54	94745.00
Not Assessed	96	21496.10
Total Number of Lakes	219	638779.00

Control Methods

NPS pollution, particularly from agricultural lands and feedlots, is the largest source of pollutants leading to the degradation of the state's lakes and reservoirs. North Dakota's NPS Pollution Management Program is very active in reducing agricultural NPS pollution. This program has kept thousands of tons of soil, along with attached contaminants, out of the state's lakes and reservoirs.

The NPS Pollution Management Program has cost-shared on 30 projects in the state and one project extending into South Dakota. These projects treat entire watersheds through the promotion of sustainable agricultural and sound land management practices. Landowner participation is voluntary, with incentives provided by cost-share programs.

Point source pollution has the potential to severely impact individual lakes and reservoirs and is the second largest pollution problem. Protection of lakes and reservoirs from point source discharges is accomplished through the NDPDES Program (see section on Point Source Program on page 11). Initially, the NDPDES Program permitted, monitored, and regulated only industrial and municipal discharges. Permits for stormwater discharges have recently been added; this will significantly help treat pollutants originating from this source.

While nearly every impoundment on a major river course is affected to some degree by point source pollution discharges, the impacts would be catastrophic without the NDPDES Program. Currently, the program regulates 13 municipal point sources and one industrial point source having the potential to directly impact lakes and reservoirs in North Dakota (Table 39).

Table 39. Number of Lakes and Reservoirs Protected Through the NDPDES Program in North Dakota

<u>Type of NDPDES Permit</u>	<u>Number of Lakes</u>	<u>Total Acres</u>
Industrial Point Sources	3	785.80
Municipal Point Sources	14	95323.00

Restoration/Rehabilitation Efforts

No new lake or reservoir restoration projects have been initiated or appear imminent. The Golden Lake Project, located in Steele County, is still operating. Initial water quality results from Golden Lake are encouraging with apparent reductions in total phosphate as phosphorus concentrations. This innovative project uses an adjacent permanent wetland to assimilate nutrients and promote sediment settling.

While no new Phase I, II, or III Clean Lakes projects are planned, there has been a great deal of interest generated with the lake water quality assessment studies. These one-year assessments provide resource managers and the public with information needed to prioritize lakes and reservoirs in their regions for further monitoring and assessment. The assessments have led to several NPS Pollution Management Projects.

Unfortunately, federal Clean Lakes funds are inadequate to complement watershed pollution control activities. However, it does appear Section 319 NPS Pollution Management funding will be available for in-lake restoration without the costly burden of a Phase I study. Also available is a more attractive cost-share percentage than that associated with Clean Lakes restoration funding. Due to this financial opportunity, the Health Department is optimistic about taking a more active role in lake restoration/rehabilitation.

Most restoration/rehabilitation activities in the state are cost-shared through the NPS Pollution Management Program (Table 40). In-lake restoration has been limited to installation of hypolimnetic drawdowns and aeration systems. Primary financing has been provided by the North Dakota Game and Fish Department, the SWC, local government entities, and sportsmen's groups (Table 41).

Table 40. Summary of Lake and Reservoir Watershed Rehabilitation Techniques Used in North Dakota

<u>Watershed Treatments</u>	<u>Number of Lakes</u>	<u>Lake Acres</u>
Industrial Point Source Permit	3	785.80
Municipal Point Source Permit	14	95323.00
Conservation Tillage	7	3064.20
Integrated Pest Management	1	1750.00
Animal Waste Management	8	3188.20
Shoreline Erosion Control/Bank Stabilization	2	21750.00
Riprapping	2	21750.00
Diversion of Nutrient-rich Inflow	1	1750.00
Unspecified BMPs	7	3064.20
State NPS Control Programs	7	3064.20
Local Lake Management Program in Place	1	1618.70
Public Information/ Education Programs/Activities	4	3837.60
Local Ordinance/Regulations to Protect Lake	1	1618.70
Integrated Crop Management	7	3064.20
NPS I&E	10	4265.20
Range/Pasture Management	8	3249.70
Improved Grazing in Forested Areas	2	414.00

Table 41. Summary of In-Lake Restoration Techniques Used in North Dakota

<u>In-Lake Treatments</u>	<u>Number of Lakes</u>	<u>Lake Acres</u>
Sediment Removal Dredging	1	63.30
Biological Control	1	1750.00
Aquatic Macrophyte Harvesting	1	1618.70
Diversion	1	203.30
Sediment Basin Traps Near Lake	2	1750.00
Drawdown	1	20000.00
Hypolimnetic Withdrawal	30	5877.10
Central Sewer System	1	1618.70
Aeration	19	3996.40
Wetland Recirculation		32355.00
Freshwater Diversion from the McClusky Canal	6	1539.80

Impaired and Threatened Lakes

As stated in the previous section, most of the state's assessed lakes and reservoirs are either threatened or impaired for aquatic life and/or recreation. The predominant pollutants causing lake and reservoir impairment are nutrient enrichment and siltation from agricultural nonpoint sources (Tables 35, 36, and 37).

Acid Effects on Lakes

Acid precipitation and acid mine drainage pose significant threats to some of the nation's lakes and streams. Most surface waters in North Dakota are naturally alkaline ($\text{pH} > 7$), while rainfall is naturally acidic ($\text{pH} < 7$). Surface waters are able to resist acidification by what is termed "buffering capacity." In surface waters, buffering capacity is maintained largely by the carbonate (CO_3^{2-}) and bicarbonate (HCO_3^{-}) ions in solution. These ions are collectively measured with hydroxide ions (OH^{-}) as total alkalinity. Acidification in surface waters occurs when the buffering capacity is exhausted, thus causing a reduction in pH.

North Dakota's lakes are highly alkaline and, as a result, do not show acidity caused by anthropogenic sources. For a more in-depth discussion of rainfall chemistry in the state, including acid rain, the reader is referred to a report published by the Health Department entitled *Ambient Air Quality, Precipitation Chemistry, and Atmospheric Deposition in North Dakota, 1980-1984*.

Toxic Effects on Lakes

Currently, mercury is the only contaminant assessed as causing lake and reservoir use impairment. As stated previously, elevated mercury concentrations in the tissues of fish have resulted in consumption advisories for 33 lakes and reservoirs, totaling 494,389 acres. Again, very little is known about the source of the mercury contamination in fish from these lakes. It is likely, however, that sources are both natural and anthropogenic.

In 1991, the department initiated the LWQA Project, in which the state's lakes and reservoirs were systematically sampled and assessed for trophic status and watershed condition. In addition to data collected to assess the general condition of each lake, data were also collected on the type, concentration, and location of contaminants like trace elements and organic compounds (e.g., pesticides, PCBs).

To date, sediments and fish have been collected from 89 lakes and reservoirs throughout the state. This data should provide useful information for determining baseline contaminant concentrations and for examining patterns in contaminant concentrations in the state's lakes and reservoirs.

Trends in Lake Water Quality

It is difficult to quantify water quality trends for most North Dakota lakes and reservoirs, because little, long-term, comparable water quality data is available. However, additional water quality data collected as part of the LWQA Project and as part of NPS Pollution assessment projects should eventually shed some "quantitative light" on this reporting requirement. It is the intention of the

Health Department to resample LWQA Project lakes at scheduled intervals (6 to 10 years). Trends will be assessed by comparing water quality and land use data collected over time.

While limited quantitative trends data exists for the state's lakes and reservoirs, an attempt was made to qualitatively evaluate trends for this report. Two lakes were assessed as "improving," nine lakes as "stable," and 113 lakes as "degrading." All lakes not quantitatively assessed for trends, but which were assessed as threatened for aquatic life and/or recreation use, were also assessed as degrading for this reporting requirement (Table 42). Where insufficient historical water chemistry, land use, or other ancillary data existed to determine trends, lakes were categorized as "unknown."

Table 42. Trophic Trends for North Dakota Lakes and Reservoirs

<u>Trend</u>	<u>Number of Lakes</u>	<u>Lake Acres</u>
Improving	2	74823.50
Stable	9	392722.50
Degrading	95	118135.30
Unknown	113	64698.70

Chapter 5. Wetlands Assessment

Background

Wetlands have long been regarded as nuisance areas or wastelands which only serve to impede agriculture, urban, or transportation development. Only recently have the ecological and social functions and values of wetlands been realized. It is now scientifically proven that wetlands are important for the storage of flood waters, for providing fish and wildlife habitat, for recharging ground water, and for retaining and cycling chemical pollutants and particulates.

While these are important wetland functions, probably the best known function of wetlands in North Dakota is that of waterfowl production. Most of North Dakota's remaining wetlands are located in an area known as the Prairie Pothole Region. This area extends from the Missouri Coteau in central North Dakota, eastward to the glacial Lake Agassiz Plain, also known as the Red River Valley. The region covers roughly 300,000 square miles, and exists as a wide band extending from Central Alberta southwest into northwestern Iowa (see Figure 9). The Prairie Pothole Region, with its many types of wetlands, is arguably the most biologically diverse and productive habitat in North America.

Extent of Wetland Resources

There seem to be as many ways to classify wetlands as there are wetlands themselves. The U. S. Fish and Wildlife Service first began to classify wetlands based on a system developed by Martin et al. (1953). This classification system was then modified by Stewart and Kantrud (1971), specifically for the Prairie Pothole Region of North America. With the Stewart and Kantrud classification system, vegetational zones are described in detail, along with the plant species most commonly found in the zone. These zones are used to identify phases which indicate the wetland's water regime or disturbed bottom soil (e.g., cropland tillage). Seven wetland classes are identified with the Stewart and Kantrud system. These include the familiar Class I - ephemeral ponds, Class II - temporary ponds, Class III - seasonal ponds and lakes, Class IV - semi-permanent ponds and lakes, and Class V - permanent ponds and lakes. Also included in the Stewart and Kantrud system are Class VI - alkali ponds and lakes, and Class VII - fens. Along with each class, there are five subclasses, A through E, based on variations in surface water salinity. Those familiar with the Stewart and Kantrud classification system refer to temporary depressional wetlands as Class II wetlands, seasonal wetlands as Class III wetlands, and semi-permanent wetlands as Class IV.

In 1979, the U. S. Fish and Wildlife Service adopted the Cowardin et al. (1979) classification system for wetlands and deep water habitats of the United States. The Cowardin et al. classification system was developed to be used with the National Wetlands Inventory. In the highest level of classification, wetlands are grouped into five ecological systems: palustrine, lacustrine, riverine, estuarine, and marine. The palustrine class includes only wetlands, whereas each of the four other systems include wetlands and associated deep water habitats. For purposes of classification, deep water habitats are defined as areas where water is greater than 6.6 feet deep. In North Dakota, only the palustrine, lacustrine, and riverine wetland types exist.

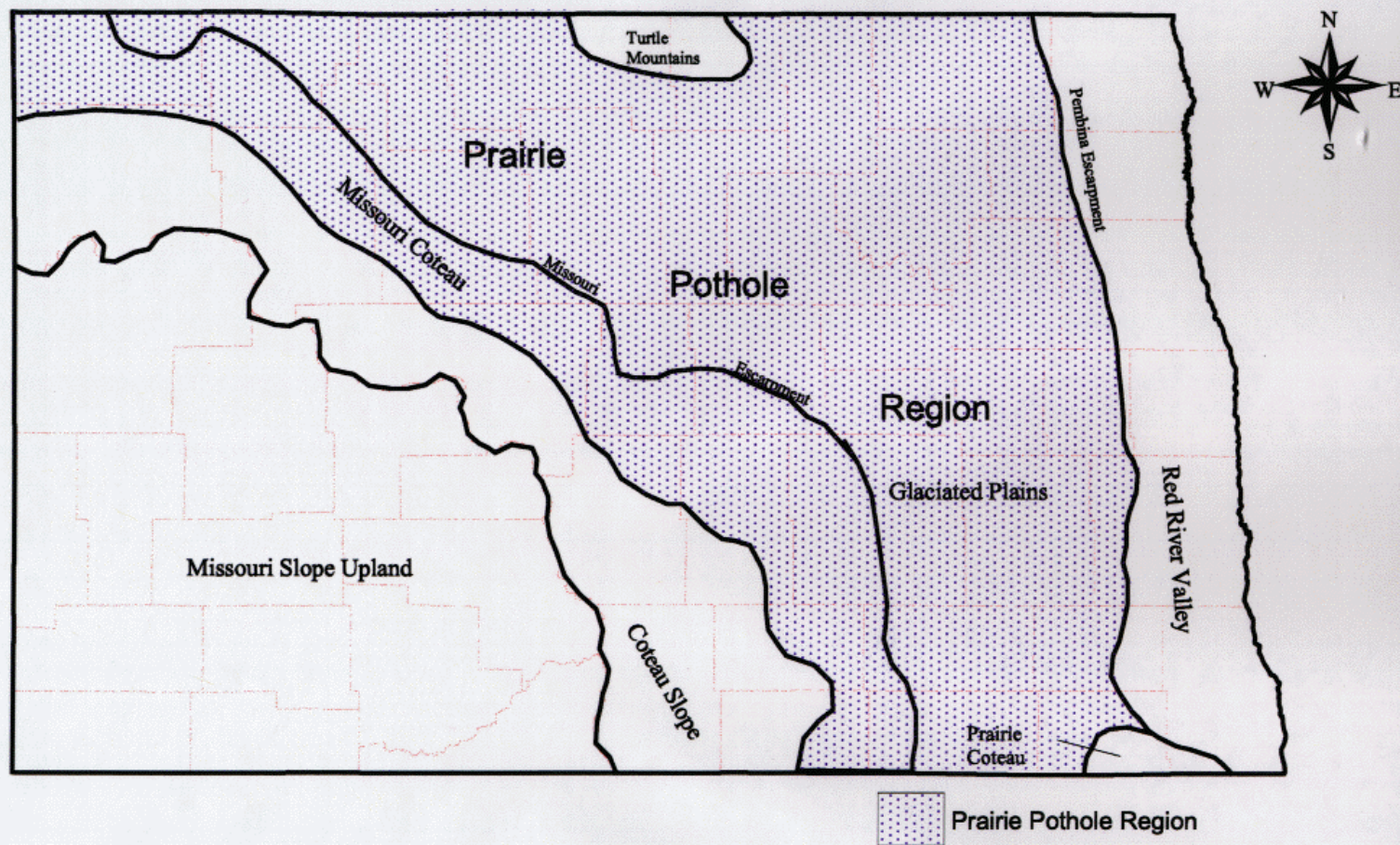


Figure 9. Prairie Pothole Region

Figure 9. Prairie Pothole Region

Brinson (1993) developed a classification system for use by the COE. This classification system, termed the Hydrogeomorphic (HGM) classification system, is based upon the wetland's position in the landscape (i.e., geomorphic setting), dominant source of water, and the flow and fluctuation of water in the wetland. Brinson (1993) describes seven HGM wetland classes: riverine, depressional, slope, mineral soil flats, organic soil flats, estuarine fringe, and lacustrine fringe.

In North Dakota, wetlands are classified into four broad categories according to the State Engineer's drainage rules. The state wetland classification includes temporary wetlands, seasonal wetlands, semi-permanent wetlands, and permanent wetlands. The following are brief descriptions of each wetland class, as adopted by the North Dakota State Game and Fish Director and the State Engineer.

"Temporary wetlands" are shallow depressions, which hold water or are waterlogged from spring runoff until early June. In years with normal runoff and precipitation, these areas may be tilled for crop production. In years with high runoff or heavy spring rain, these areas may not dry out until mid-July. They cannot be tilled, but may be used for hayland or pasture. Temporary wetlands frequently reflood during heavy summer and fall rains. Sheet water, as defined in North Dakota's Century Code 61-32-02, does not fall under the temporary wetland classification.

"Seasonal wetlands" are depressions, which normally hold water from spring runoff until mid-July. In years with normal runoff and precipitation, these wetlands cannot be tilled, but may be used for hayland and pasture. In low runoff or dry years, these areas may be tilled for crop production, but commonly reflood with heavy summer and fall rains.

"Semi-permanent wetlands" are located in well-defined depressions or basins. In normal years, these areas hold water throughout the summer. Semi-permanent wetlands generally become dry only in years of below normal runoff and precipitation. Freshwater semi-permanent wetlands (commonly called cattail sloughs) are characterized by a predominance of cattail and bulrush vegetation in scattered open-water areas. Saline semi-permanent wetlands have a preponderance of alkali bulrush in scattered areas of open-water.

"Permanent wetlands" are located in well-defined basins, which characteristically hold water throughout the year. The wetlands become dry only after successive years of below normal runoff and precipitation. Freshwater permanent wetlands typically have a border of aquatic vegetation and predominant open-water areas in the interior. Saline permanent wetlands are typically devoid of emergent vegetation and exhibit a white, salt-encrusted shoreline.

As of this report, there are no accurate estimates of state wetland acreage based on wetland class. Statewide, it is estimated there are approximately 2.5 million acres of wetlands. When compared to the approximately 4.9 million acres of wetlands which covered North Dakota prior to development, this represents a 49 percent reduction in wetlands. Stewart and Kantrud (1973) divided the state into four biotic regions: the Prairie Pothole Region, the Lake Agassiz Plain Region, the Coteau Slope Region, and the Southwestern Slope Region. They estimated that 81 percent of the wetlands in the state are located in the Prairie Pothole Region. More than 90 percent of all wetlands in the state are considered natural basin wetlands, commonly referred to as prairie potholes. Furthermore, it is estimated that 78 to 79 percent of wetland basins in the Prairie Pothole Region are less than one acre in size (Ron Reynolds, personal communication). While the rate of wetland loss in the state seems to

be decreasing, it is safe to assume that wetland losses still exceed wetland gains.

Integrity of Wetland Resources

Wetland integrity should be thought of in terms of whether a wetland performs a set of functions or uses which would be expected for natural or “reference” wetlands of a similar class or type. The NRCS and the COE has described 11 specific functions within three general functional categories for temporary and seasonal Prairie Pothole wetlands (Lee et al., 1997) (Table 43). Therefore, whenever a wetland’s function is diminished, it can be said that wetland integrity is diminished.

Hydrologic manipulation (e.g., drainage, wetland consolidation, channelization, filling) continues to be the greatest impact on the integrity of the state’s wetlands. While not as dramatic, other factors such as chemical contamination, nutrient loading (i.e., eutrophication), and sedimentation can also affect a wetland’s function and, therefore, its chemical, physical, and biological integrity.

Landscape level changes outside the edge of the wetland basin can also negatively affect wetland integrity. Changes to the landscape, such as road construction, cropland conversion, urbanization, or the drainage of adjacent wetlands, all affect wetland functions in its landscape. Cowardin et al. (1981) found that in a 3,877-square-mile area of the Prairie Pothole Region, 40 percent of wetlands were cultivated to the wetland edge, 33 percent were in pasture, and 7 percent were hayed.

When viewed on a larger scale, wetlands are part of a larger unit known as a wetland complex. Wetland complexes are aggregates of wetlands which are hydrologically connected. A typical wetland complex includes recharge wetlands, flow-through wetlands, and discharge wetlands. Recharge wetlands are typically located at higher elevations in the landscape and receive the majority of their hydrologic budgets from precipitation and surface runoff. Recharge wetlands get their name because they recharge ground water. Flow-through wetlands, as their name implies, receive surface and ground water inflow, and then outflow to both surface and ground water. Discharge wetlands receive the majority of their hydrologic budgets from ground water discharge, and rarely outflow to surface water. Because recharge wetlands receive most of their water through precipitation and surface water inflow, they tend to be fresher, while discharge wetlands, receiving most of their water from ground water, tend to be higher in TDS.

Due to this hydraulic linkage in the landscape, any land use change which affects or changes the hydrologic relationship of wetlands in the complex can and will affect the hydrologic or physical integrity of each wetland in the complex. This, in turn, affects both the chemical and biological integrity of wetlands in the complex.

In order to quantify the extent to which wetlands are performing a prescribed set of functions at their optimal level, it will be necessary to develop and calibrate a set of functional assessment models. These models use a set of indicators, which serve as surrogates for the function. Once these models are developed, it will then be possible to statistically sample wetlands over a large area in order to assess wetland integrity. These same models or tools will also allow wetland managers to assess the integrity of individual wetlands for regulatory purposes (e.g., Section 404).

Table 43. Definitions of Functions for Temporary and Seasonal Prairie Pothole Wetlands
(Lee et al. 1997)

<p><u>Physical/Hydrologic Functions</u></p> <p>Maintenance of Static Surface Water Storage. The capacity of the wetland to maintain a hydrologic regime that supports static storage, soil moisture in the unsaturated zone, and ground water interactions.</p> <p>Maintenance of Dynamic Surface Water Storage. The capacity of the wetland to maintain a hydrologic regime that supports dynamic storage, soil moisture in the unsaturated zone, and ground water interactions.</p> <p>Retention of Particulates. Deposition and retention of inorganic and organic particulates ($>0.45 \mu\text{m}$) from the water column, primarily through physical processes.</p>
<p><u>Biogeochemical Functions</u></p> <p>Elemental Cycling. Short- and long-term cycling of elements and compounds on-site through the abiotic and biotic processes that convert elements (e.g., nutrients and metals) from one form to another; primarily recycling processes.</p> <p>Removal of Imported Elements and Compounds. Nutrients, contaminants, and other elements and compounds imported to the wetland are removed from cycling processes.</p>
<p><u>Biotic and Habitat Functions</u></p> <p>Maintenance of Characteristic Plant Community. Characteristic plant communities are not dominated by non-native or nuisance species. Vegetation is maintained by mechanisms, such as seed dispersal, seed banks, and vegetative propagation which respond to variations in hydrology and disturbances, such as fire and herbivores. The emphasis is on the temporal dynamics and structure of the plant community as revealed by species composition and abundance.</p> <p>Maintenance of Habitat Structure Within Wetland. Soil, vegetation, and other aspects of ecosystem structure within a wetland are required by animals for feeding, cover, and reproduction.</p> <p>Maintenance of Food Webs Within Wetland. The production of organic matter of sufficient quantity and quality to support energy requirements of characteristic food webs within a wetland.</p> <p>Maintenance of Habitat Interspersion and Connectivity Among Wetland. The spatial distribution of an individual wetland in reference to adjacent wetlands within the complex.</p> <p>Maintenance of Taxa Richness of Invertebrates. The capacity of a wetland to maintain characteristic taxa richness of aquatic and terrestrial invertebrates.</p> <p>Maintenance of Distribution and Abundance of Vertebrates. The capacity of a wetland to maintain characteristic density and spatial distribution of vertebrates (aquatic, semi-aquatic, and terrestrial) that utilize wetlands for food, cover, and reproduction.</p>

Development of Wetland Water Quality Standards

As the lead water quality agency in the state, the Health Department is responsible for developing and implementing water quality standards. In general, the *State Water Quality Standards* are regulations which specify the beneficial uses of lakes, reservoirs, rivers, and streams in North Dakota. The standards include narrative descriptions, numeric criteria, and an antidegradation policy to protect beneficial uses. Common beneficial uses for the state's lakes and rivers are recreation (e.g., swimming, wading, boating, skiing), fishing, drinking water supply, and aquatic life. Agriculture (i.e., stock watering and irrigation) and industrial uses for water are also recognized.

The *State Water Quality Standards* already include wetlands in the state's definition of waters of the state. However, beneficial uses have not yet been assigned to wetlands, nor have numeric limits been assigned to protect those uses. Wetlands have been provided with some water quality protection by applying North Dakota's narrative standards to wetlands. These narrative standards, also known as the "free from" standards, prohibit the disposal of garbage, oil, or any toxic pollutant to wetlands. In order to further develop water quality standards for the protection of the state's wetlands resources, the Health Department has developed a strategy or proposed implementation method. This strategy entitled, *A Summary of Wetland Classification Systems and a Strategy for the Development of Water Quality Standards for Wetlands in North Dakota* (Fritz, 1994), was completed in June 1994.

The following is a brief summary of this strategy. Table 44 summarizes the state's progress in developing water quality standards for wetlands.

Since wetlands are currently recognized as waters of the state, the first step is to provide a clear definition describing what is (and what is not) a wetland, thereby defining what will (and what will not) be protected by *State Water Quality Standards*. The process of defining a wetland, commonly referred to as wetland delineation, should not be confused with wetlands classification. Wetland delineation is a method of determining the presence of wetlands and their boundaries, whereas classification is any method used to describing a group of wetlands based on a prescribed set of physical, hydrological, and/or biological factors. While the public generally recognizes the presence or absence of lakes, reservoirs, rivers, and streams, there remains considerable confusion as to what is (and what is not) a wetland.

Table 44. Summary of North Dakota's Progress in Developing Water Quality Standards for Wetlands

	In Place	Under Development	Proposed
Use Classification		X	
Narrative Criteria		X	
Numeric Criteria		X	
Narrative Biocriteria		X	
Numeric Biocriteria		X	
Antidegradation		X	
Implementation Method	X		

In January 1994, a Memorandum of Understanding (MOA) was signed by the EPA, USDA, U. S. Department of Interior, and the COE. In this MOA, the parties agreed that the NRCS would be responsible for conducting all wetland delineations on agricultural lands, while the COE and EPA would conduct delineations for Section 404 purposes. The MOA further agreed that the NRCS would use procedures described in the National Food Security Act Manual (NFSAM) to delineate wetlands on agriculture lands, while the 1987 COE Wetland Delineation Manual would be used by the COE and EPA. For purposes of the MOA, the term "agricultural lands" refers to those lands intensively used and managed for the production of food and fiber. To the extent that the natural vegetation has been removed, it cannot be used to determine whether the area meets the applicable hydrophilic vegetation criteria necessary to make a wetland delineation.

Since by definition wetlands and agricultural lands lack the vegetation necessary to make a delineation using the 1987 Delineation Manual, the NRCS is required to delineate wetlands using a set of mapping conventions. These mapping conventions are used to ensure consistency among NRCS field offices and are to be used as a method to determine whether a wetland exists on agricultural land. For Food Security Act purposes, wetland delineations are the responsibility of the NRCS District Conservationist. In most cases, the delineation is done using existing maps (e.g., soil survey maps, National Wetland Inventory maps, ASCS 35-mm color slides, color infrared photography, black and white aerial photography, USGS topo maps) for "off-site" wetlands determination. If, however, a "scope and effect" determination is required, the producer requests reconsideration or appeals the determination, or a wetland boundary delineation is required, an on-site visit may be required. Where an on-site wetland delineation is performed, the NRCS will utilize those procedures found in the COE 1987 Wetland Delineation Manual.

On "non-agricultural" lands, the COE and EPA jointly regulate wetlands under Section 404 of the Clean Water Act. Under Section 404 of the Clean Water Act, the COE and EPA jointly define wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of

vegetation typically adapted for life in saturated soil conditions.” The COE and EPA have translated this definition to a 3-parameter delineation test that includes vegetation, soils, and hydrology. The following are brief descriptions for each of these delineation categories. Furthermore, in order for a wetland to be delineated, a minimum of one positive indicator for each parameter (vegetation, soils, hydrology) must be found.

Vegetation: The prevalent vegetation consists of macrophytes typically adapted to areas having hydrologic and soil conditions prescribed in wetlands, as defined by the COE and EPA. Hydrophytic species, due to morphological, physiological, and/or reproductive adaptation(s), have the ability to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions.

Soils: Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.

Hydrology: The area is inundated, either permanently or periodically, at mean water depths less than or equal to 6.6 feet, or soil is saturated to the surface at some time during the growing season.

While federal regulations provide for a method to delineate or define wetlands, North Dakota does not have a prescribed wetland delineation method. In other words, the state does not have a set of methods or criteria for delineating what is (or is not) a wetland. Rather, the state regulates wetland drainage through a set of rules or regulations which require a permit to drain any pond, slough, lake, sheet water, or any series thereof, having a watershed of 80 acres or more.

In developing water quality standards for wetlands, it is likely that North Dakota will adopt the federal definition of wetlands, in conjunction with the use of federal delineation methods. Through this strategy, wetland water quality standards would only apply to waterbodies which are defined or delineated as wetlands through federal law or regulation.

The next step in developing wetland water quality standards is to define beneficial uses for wetlands. It should be recognized that the purpose of protecting wetlands (as is the purpose of protecting or restoring other surface waters) is not to protect the waterbody in and of itself, but to protect its uses, functions, and values deemed beneficial by the public. As stated previously, beneficial uses have been defined for lakes, rivers, and streams. Beneficial uses for wetlands will likely be dependent upon wetland class or type. In much the same way that some Class I, IA, II, and III streams provide different uses, one class of wetlands may provide one set of functions, whereas other classes and types of wetlands may provide a different set of functions. For example, riparian wetlands do not provide the same functions as depositional wetlands, or do not perform the same functions at the same levels.

Wetland values are related to wetland functions in that the values are those functions considered to be beneficial to society and the environment. Values can also include activities, such as hunting, fishing, or even bird watching. It is these functions and values of wetlands that will be incorporated into the *State Water Quality Standards* as beneficial uses.

The third step in the state's strategy to develop water quality standards for wetlands is to develop narrative criteria, including narrative biological criteria. Narrative criteria are general statements designed to protect a specific designated use or set of uses. Narrative criteria can be statements that prohibit certain actions or conditions (e.g., "free-from" standards) or can be statements which describe what is expected to occur in the water (e.g., "Water quality and aquatic life shall be as it naturally occurs."). Narrative water quality criteria will be particularly important for protecting wetlands since many wetland impacts cannot be fully addressed by numeric criteria. Such impacts may result from the discharge of chemicals for which there are no numeric criteria, those which are from nonpoint sources, or from activities that may affect the physical and/or biological integrity of a wetland (e.g., the discharge of dredged and fill material).

Narrative biological criteria are general statements that describe conditions in wetlands necessary to maintain the biological integrity of a wetland and/or those beneficial uses associated with biological integrity (e.g., aquatic life use).

The fourth step identified in the state's strategy is to adopt numeric criteria to protect wetland beneficial uses. Numeric criteria are specific numeric values for chemical constituents (typically expressed as a concentration in water), physical parameters, or biological conditions that are adopted in state standards. These may be values that are not to be exceeded (e.g., toxics), values that must be exceeded (e.g., DO greater than 5 mg/L), or a combination of the two (e.g., pH between 6 and 9). Numeric criteria fall into two categories: criteria to protect human health and criteria to protect aquatic life. Human health water quality criteria are based on the toxicity of the contaminant and the amount of the contaminant consumed through ingestion of water and fish. Aquatic life criteria are numeric limits which are recommended for the protection of fresh water and salt water aquatic life. Aquatic life criteria can be divided into two basic categories: 1) chemicals that cause toxicity to aquatic life, such as metals, ammonia, and chlorine in organics, and 2) other water quality characteristics, such as DO, alkalinity, salinity, pH, and temperature. Since very little is known about the chemical and physical quality of wetlands, it may be necessary to conduct extensive monitoring over a wide range of wetland classes in order to determine the applicability of existing numeric criteria to wetlands.

Anti-degradation policies are also an important part of *State Water Quality Standards* and should include provisions to protect wetlands. Since wetlands are included in the definition of waters of the state, anti-degradation policies and their implementation methods should apply to wetlands in the same way as they do to other surface water resources. It is recognized that, with regard to the issuance of any wetland fill permit under Section 404 of the Clean Water Act, the state anti-degradation policy should be flexible with regard to fills in wetlands if the discharge does not result in "significant degradation" to the aquatic ecosystem.

As stated earlier, the Health Department is implementing its strategy to develop water quality standards for wetlands, and the *State Water Quality Standards* are currently being revised as part of the triennial review. As part of this review, the state will be proposing use classifications for wetlands and developing narrative criteria, including narrative biological criteria, for wetlands. The state's anti-degradation policy is also being revised with wetlands protection in mind.

In support of efforts to develop both narrative and numeric biological criteria, the department has

initiated a series of projects to develop an IBI for temporary, seasonal, semi-permanent, and permanent depressional wetlands in North Dakota. These projects, which began in 1995, were supported through the use of EPA Section 104(b)(3) grant funds. In general, direct measures of the aquatic biota in wetlands are used. Through a multi-metric approach, these measurements (or metrics) are combined into an overall IBI for wetlands.

To date, the Health Department has sampled approximately 30 temporary and seasonal depressional wetlands over a wide disturbance gradient, from severely impaired wetlands to pristine wetlands. The department is currently in the process of developing biological metrics for three biological assemblages: macroinvertebrates, vegetation, and phytoplankton. Beginning in 1998, plans call for continuation of this approach by sampling and developing an IBI for semi-permanent and permanent depressional wetlands. Other wetland classes are types which should be considered in the development of an IBI, including riverine wetlands and fens. As the state develops IBIs for wetlands, it may also be necessary to further stratify depressional wetlands, based on water chemistry (e.g., fresh water, saline) or ecoregion.

Additional Wetland Protection Activities

State-led wetland protection activities took a step backward in 1995 with the repeal of North Dakota's "no-net-loss" law. The no-net-loss law and accompanying regulations required the State Engineer and the director of the North Dakota Game and Fish Department to jointly review drainage permit applications and to ensure that any wetlands proposed to be drained would be replaced by an equal acreage of replacement wetlands. In order to determine replacement requirements, the area of a wetland was jointly determined with the normal water level for the wetland. Under no-net-loss, it was only necessary to replace wetlands with wetlands of equal size. It was not necessary to replace drained wetlands with restored wetlands of the same type or classification (i.e., similar wetland functions).

Currently, the only remaining state programs which can be used for wetland protection are the 80-acre drainage permit law and accompanying regulations, and the State Waterbank Program. Under state law, landowners are required to obtain a permit to drain any pond, slough, lake, sheet water, or any series thereof, having a watershed of 80 acres or more. The person proposing to drain land must apply to the State Engineer, who must then determine whether the proposed drainage is of "statewide significance." If it is not of statewide significance, the decision to grant a permit is made by the local WRD. If it is of statewide significance, the local WRD is required to make a decision regarding the permit. The WRD then returns its decision to the State Engineer, who is required to hold a hearing, review the permit, and either approve or deny the action taken by the WRD.

The State Waterbank Program was created by state law in 1981. Modeled after the federal Waterbank Program, the program's goal is to protect, enhance, restore, and manage wetland ecosystems in North Dakota through 5- or 10-year renewable leases. Landowners interested in applying for State Waterbank Program assistance can apply at their local NRCS, U. S. Fish and Wildlife Service, or North Dakota Game and Fish Department. Applications are then rated and submitted to a state assessment team for recommendation to the State Commissioner of Agriculture. In order to qualify for State Waterbank Program assistance, tracts of land should have at least a 1:4 ratio of wetlands to uplands. Priority is also given to land with a high wetland destruction

potential, or to wetlands that have been drained.

Federal laws, regulations, and programs remain the most effective wetland protection tools in North Dakota. Some of the more important laws related to wetlands protection are contained in the 1899 Rivers and Harbors Act, the 1972 Clean Water Act and its amendments, the 1985 Food Security Act, the 1990 Food Agriculture Conservation and Trade Act, and the 1986 Emergency Wetlands Resources Act. Under Section 10 of the Rivers and Harbors Act, the COE has authority to regulate activities, such as diking, deepening, filling, excavating, and the placing of structures in navigable waters.

The 1986 Emergency Wetlands Resources Act was enacted by Congress to help promote the protection of the nation's wetlands for their value as food supply, water supply, water quality, flood control, and for fish and wildlife habitat. Through an amendment to the Land and Water Conservation Fund Act, the law required all states to append a wetlands priority plan to their State Comprehensive Outdoor Recreation Plans (SCORP). The wetlands priority plan identifies locations and types of wetlands, and public interest in wetlands that should receive priority for state wetland acquisition projects. Wetland priorities should be based on historic wetland losses, functions and values of wetlands, and future threats to wetlands. With funding to states under the Land and Water Conservation Act discontinued, North Dakota's most recent SCORP includes a reference to wetlands but does not include a wetlands priority plan.

The 1986 Emergency Wetlands Resources Act also required the U. S. Fish and Wildlife Service to map and inventory the nation's wetlands (known as the National Wetlands Inventory) and to provide updated reports on the status and trends of wetlands in the conterminous United States on a 10-year cycle.

The "swampbuster" provisions of the 1985 Food Security Act and the 1990 Food Agriculture Conservation and Trade Act provide wetland protection on agricultural lands. Producers enrolled or receiving USDA benefits are prohibited from draining and filling wetlands for agricultural purposes. Wetlands converted for agricultural purposes prior to December 23, 1985, are exempt from the swampbuster provisions; however, any producer who otherwise drains, fills, or alters a wetland for agricultural purposes after that date is subject to losing his USDA benefits.

The 1990 Food Agriculture Conservation and Trade Act also authorizes the federal government to purchase conservation easements from landowners who agree to protect and restore wetlands through the Wetland Reserve Program. Both swampbuster and the Wetland Reserve Program are administered through the Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service). The NRCS is responsible for determining compliance with swampbuster provisions, and is required to assist farmers in the delineation of wetlands and in the development of wetland protection restoration or creation plans.

Of all the federal wetland protection activities, none is probably more well-known than Section 404 of the Clean Water Act. Under Section 404 of the Clean Water Act, the COE issues permits regulating the discharge of dredge or fill material into waters of the United States, including wetlands. All permits issued by the COE are subject to review and possible veto by EPA. In general, normal farming and ranching activities are exempt from Section 404 permits.

Related to Section 404 permits, the Health Department has been granted authority from EPA to give Section 401 Water Quality Certification for all Section 404 permit activities. Some nationwide permits are certified with conditions, while other applicants are denied so they can be considered individually. Individual permits are reviewed for Section 401 certification in the context of physical and chemical water quality criteria. Chemical testing of sediment and/or fill material is required when it is suspected that acute or chronic chemical criteria may be exceeded due to the Section 404 activity. In all cases, nationwide or individual permits, the department's "construction and environmental disturbance" requirements are required.

Private organizations play an important role in the protection and conservation of wetlands in the state. Among them are Ducks Unlimited and the Nature Conservancy. Ducks Unlimited is an internationally recognized organization that works cooperatively with federal, state, and private landowners to restore and enhance wetlands and associated upland habitats for waterfowl and wildlife production. The Nature Conservancy is involved in preserving rare and unique habitats, including wetland habitats.

A third organization which is unique to North Dakota is the Wetlands Trust. Born out of conflicts over the Garrison Diversion Project, Congress created the Wetlands Trust to "preserve, restore, manage, and enhance wetlands and associated wildlife habitat in North Dakota" (Public Law 99-294) (North Dakota Wetlands Trust, 1997). Activities of the trust are managed through a six-member Board of Directors. By federal law, the board includes: three members appointed by the governor, one appointed by the National Audubon Society, one by the National Wildlife Federation, and one by the North Dakota Chapter of The Wildlife Society. The trust has appointed the North Dakota Game and Fish Director as an ex-officio director.

Funding for the North Dakota Wetlands Trust is provided through Public Law 99-294, which authorizes the Bureau of Reclamation to provide a total of \$12 million for the trust. Payment is made on a scheduled proportion of the annual federal appropriation for the Garrison Diversion Unit. Federal law also requires the state of North Dakota to contribute 10 percent (\$1.2 million) to the trust. In order to carry out its mission the trust is authorized to use only the interest monies generated from the principal.

During development of the legislation leading to the creation of the North Dakota Wetlands Trust, the parties involved agreed that the trust should consider innovative approaches to wetland protection and complement existing wetland programs.

While the trust is authorized to acquire land from willing sellers, North Dakota's nonprofit corporate farming law (North Dakota Century Code {NDCC} 10-06-04.3) restricts this activity. The law restricts the trust's land acquisition to a total of 12,000 acres and requires a review and public hearing by both the county commission and a nonprofit acquisition committee composed of representatives of five state agencies, the North Dakota Farm Bureau, and the North Dakota Farmers Union.

The law also requires approval from the governor for any land acquisition. Further, the law prohibits the North Dakota Wetlands Trust from transferring land to the federal government and requires all land to be managed to conserve wildlife habitat.

Chapter 6. Public Health/Aquatic Life Concerns

Size of Waters Affected by Toxicants

A total of 2,979 miles of rivers and streams and 515,013 acres of natural lakes and reservoirs were considered monitored for toxic pollutants for this report (Table 45). Monitoring consisted mainly of sampling trace metals and organics (i.e., pesticides) in the water column and monitoring fish flesh for trace metals, including mercury and selected organics. In general, all fish tissue samples were analyzed for mercury while large fish were also analyzed for trace metals and organic compounds (e.g., pesticides, PCBs). Fish tissue monitoring represented 452 miles of the 2,979 miles of rivers and streams sampled for toxics and all of the lake acres monitored for toxic pollutants.

A total of 827 miles of rivers and streams and 494,389 acres of lakes and reservoirs displayed “elevated” concentrations of toxics either in the water column or in fish tissues (Table 45). For purposes of this report elevated concentrations of toxic pollutants in the water column are defined as exceedances of the numeric *State Water Quality Standards* for metals, organics compounds, and pesticides. Numeric criteria for toxic pollutants have been established by EPA through authority granted in Section 307(a) of the Clean Water Act. The Health Department has subsequently adopted these criteria as water quality standards, and they are listed in the *State Water Quality Standards*. Where fish tissues have been sampled and analyzed for contaminants, elevated concentrations are those contaminant levels which result in the department issuing a fish consumption advisory for the waterbody. To date, mercury is the only contaminant which has resulted in fish consumption advisory information.

Table 45. Total Waterbody Size Affected by Elevated Levels of Toxic Pollutants

<u>Waterbody Type</u>	<u>Size Monitored for Toxics</u>	<u>Size with Elevated Levels of Toxics</u>
Rivers (miles)	2,979	827
Lakes (acres)	515,013	494,389

Of the 827 miles of rivers identified in this report as having elevated levels of toxic pollutants, 452 miles were identified due to mercury in fish tissues. The remaining 375 miles were listed due to trace element concentrations which exceeded *State Water Quality Standards*. Rivers which displayed elevated trace element concentrations were the Souris River, Sheyenne River, Elm River, Little Missouri River, and the lower reaches of the Turtle, Forest, and Park Rivers. During periods of low flow, the lower reaches of the Turtle, Forest, and Park Rivers are under the influence of ground water discharges from the Dakota Aquifer. This aquifer, which originates in Wyoming, contains naturally high concentrations of selected trace elements (e.g., selenium).

Public Health/Aquatic Life Impacts

Examples of public health or aquatic life impacts include fishing advisories or bans, pollution-caused fish kills or abnormalities, known sediment contamination, discontinued use of drinking water supplies, closure of swimming areas, or incidents of waterborne disease.

Unlike many other states, North Dakota has had no reported incidents of drinking water supply restrictions or swimming beach closures for the reporting period 1994 to 1995. One site has been identified as having contaminated sediments. This waterbody is English Coulee located near Grand Forks. A site assessment conducted by EPA has shown elevated concentrations of pesticides in stream sediments. Runoff from an abandoned landfill and pesticide formulating plant is suspected to be the source of contamination.

Fish kills occur periodically in the lakes and rivers of the state. When they do occur, it is generally the result of low water conditions, heavy snow cover, or both. Because most fish kills occur during the winter, documenting their occurrence and extent is difficult. In most instances, the occurrence of fish kills is inferred through spring test netting by the North Dakota Game and Fish Department.

The primary public health concern in the state associated with lakes and streams in North Dakota is mercury contamination. In March 1991, the state issued its first fish consumption advisory for lakes and rivers. Each year the Health Department updates the consumption advisory based on new information gathered the year before. Tables 46 and 47 show the individual rivers and lakes for which the department has provided a consumption advisory. As stated previously, the consumption advisory for all rivers and lakes in the state is due to elevated concentrations of methyl-mercury in fish tissues. To date, no specific source of mercury contamination has been identified.

Table 46. Rivers Affected by Fish Consumption Advisories for Mercury

Waterbody <u>Name</u>	Size <u>Affected (miles)</u>
Missouri River	125.1
Red River	305.0
Yellowstone River	21.6

Table 47. Lakes Affected by Fish Consumption Advisories for Mercury

Waterbody Name	Size Affected (acres)
Lake Ashtabula	5,430.0
Lake Audubon	20,000.0
Blacktail Dam	160.0
Bowman-Haley Dam	1,750.0
Braddock Dam	69.5
Brewer Lake	128.0
Lake Darling	9,458.4
Devils Lake	74,500.0
East Park Lake	170.6
Epping Springbrook Dam	151.1
Fordville Dam	197.0
Indian Creek Dam	222.0
Heckers Lake	195.7
Lake Holmes	427.5
Jamestown Reservoir	2,086.0
Kolding Dam	9.8
Kulm-Edgeley Dam	28.7
Lake LaMoure	495.0
McGregor Dam	54.3
McVille Dam	33.4
Lake Metigoshe	1,618.7
Mt. Carmel Dam	337.0
Nelson Lake	660.0
New Johns Lake	614.7
Pheasant Lake	232.1
Pipestem Dam	892.0
Lake Sakakawea	368,231.0
Silver Lake	91.0
Spiritwood Lake	412.4
Sweetbriar Dam	270.6
Tolna Dam	152.0
Lake Tschida	5,018.0
West Park Lake	328.8

The advisory consists of two groups of fish, termed A and B. In general, Group A consists of the smaller fish and generally have lower concentrations of mercury. The Health Department's advisory recommends that sensitive persons, such as pregnant women, women of childbearing age, and children under the age of seven, consume only two meals (8 ounces) of these fish per month. The advisory further recommends that sensitive persons eat no Group B fish. This is because Group B fish are larger and have higher concentrations (greater than 0.75 μg of mercury per gram of fish tissue) of mercury in their flesh. The consumption advisory for sensitive persons is more restrictive because the effects of mercury on them is largely unknown. In addition, the vulnerability of

children and unborn children could be greater than that of adults. Nonsensitive persons may eat freely from Group A fish and follow consumption recommendations for Group B fish.

When the Health Department issues a consumption advisory for a river, lake, or reservoir only the largest size of fish collected for a species is reported. For example, if walleye of less than 20 inches in length are collected and analyzed, then the advisory would be only for walleye 20 inches long or less. There would be no consumption advisory for walleye greater than 20 inches in length. For more information on the state's fish advisory, the reader is encouraged to contact the department at the address contained in the front of this report.

PART IV. GROUND WATER ASSESSMENT

Description

Ground water in North Dakota occurs in two major rock types referred to as unconsolidated rock and bedrock (underlying the unconsolidated rock). Aquifers in the unconsolidated rock are primarily the result of glacial outwash deposits of the Quaternary Age and are called glacial drift aquifers. These deposits are typically more productive and generally yield less mineralized water than that of the underlying bedrock. At the present time, approximately 192 separate glacial drift aquifers have been identified and delineated throughout the state. Figure 10 indicates the general location and areal extent of the primary glacial drift aquifers in the state.

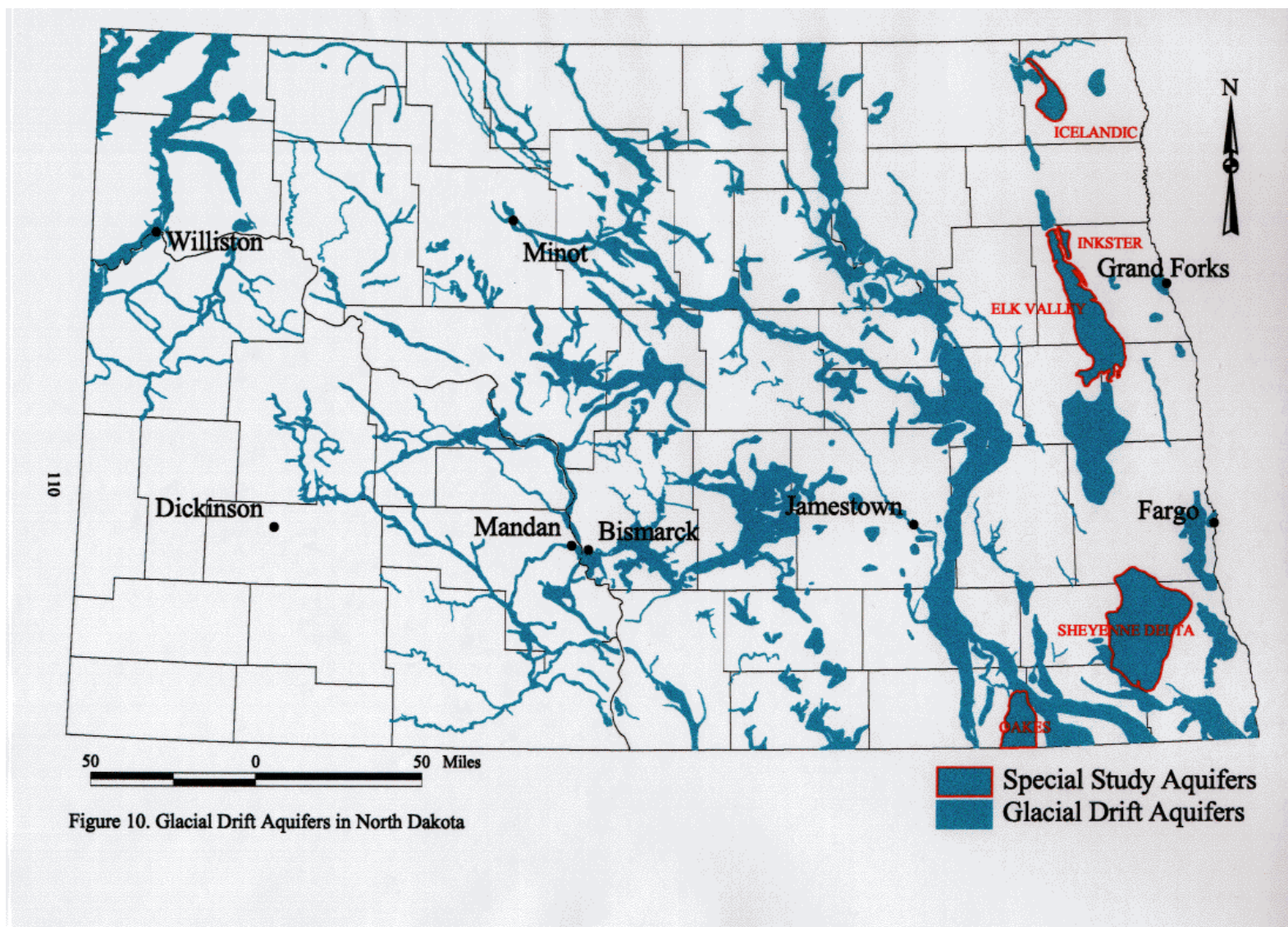


Figure 10. Location and Extent of North Dakota's Primary Glacial Drift Aquifers

Bedrock aquifers tend to be more continuous and widespread than aquifers in the unconsolidated rocks. Water from bedrock aquifers tends to be more mineralized and occurs primarily along fractures in the rock. The major bedrock aquifers include the Dakota, Pierre, and Fox Hills-Hell Creek Aquifers of the Cretaceous Age and the Fort Union Aquifer of the Tertiary Age. Figure 11 indicates the general location and areal extent of the primary bedrock aquifers in the state.



Figure 11. Location and Extent of North Dakota's Primary Bedrock Aquifers

North Dakota has completed a multi-agency effort to assess and map the major ground water resources found within state boundaries. Information from the individual aquifer assessments are presented in separate county reports. The reports were completed through a cooperative effort of the SWC, the North Dakota Geological Survey, USGS, county WRDs, and county commission boards. This cooperative program resulted in the completion of geological and ground water resource evaluations in the state's 53 counties over a 25-year period. The information was published in three-part reports as described below:

Part I. Geological Report - This section contains a discussion and map of the surficial geology of the county. Information in the report includes a discussion of county stratigraphy, unit descriptions, lithologies, and subsurface geology.

Part II. Basic Ground Water Data - This portion of the report contains basic ground water data collected during field studies. Information provided includes drilling logs of test holes drilled for the project, descriptive lithologic logs, and geophysical logs that were completed during the study. Information on private and public domestic drinking water wells is provided in each report with well location and associated

construction information included. Ground water elevation data for selected wells is presented, along with chemical analyses for all wells sampled during the project.

Part III. Ground Water Resources - This part contains a description of the primary ground water resources of the county. Each report contains a potential ground water yield map with the general location of the major aquifer boundaries. Information in the text includes aquifer area, thickness, lithology, potential discharge areas, and information regarding regional flows in the aquifer. The water chemistry of each aquifer and the potential uses of the water based upon quality are also discussed.

The final county report was completed in 1985, ending the first phase of the 25-year, county-by-county, ground water resource evaluation program. The reports are used by various agencies involved in the protection and regulation of the state's ground water resources. The SWC and other federal and state agencies continue to evaluate the ground water resources and expand the available knowledge of the quantity and quality of these resources.

Water Use

It is estimated North Dakota has approximately 470 MAF of water stored throughout the various aquifer systems. Although these systems are abundant and widely dispersed, consumptive use demands, accessibility, and overall quality has limited the use of ground water for beneficial applications in some areas.

Consumption of ground water in North Dakota has historically been categorized as agricultural (e.g., irrigation or livestock watering), industrial, and domestic (private or public) use. In 1996, it was estimated that the highest consumptive use of ground water was related to agricultural irrigation. Other uses such as public water supply, industrial, domestic (private water wells), and livestock followed in decreasing consumptive use quantities. Table 48 identifies the consumptive use for each category as estimated in 1996.

Table 48. Consumptive Ground Water Use in North Dakota (1996 Estimate)

Consumptive Use	Acre-Feet
Irrigation	268,290
Public Water Supply (municipal/rural water)	91,113
Industrial	27,136
Domestic	1,755
Miscellaneous (recreation, livestock, fish & wildlife, multiple use)	644
Total	388,938

When compared to the total quantity of ground water stored in the state's aquifers, less than 1 percent of the ground water resource is used. The majority of all water use is typically concentrated in small geographical locations. This is considered to be a function of several factors, including accessibility and water quality. It is anticipated that some ground water systems may experience competing future uses approaching or equalling the capacity of a specific aquifer. This situation is expected to be aggravated by increasing demands from drinking water supply, industrial, and irrigation interests.

Ground Water Contamination Sources

Contamination of ground water from anthropogenic sources has occurred in every county of the state. The degree to which contamination incidents are investigated or remediated is a function of the contaminant, its impact on the beneficial use of the resource, and the overall risk it poses to the public or environment. Due to funding limitations, ground water protection programs and contamination assessments are addressed on a site-by-site basis. Table 49 identifies the current contaminant sources which have been identified as most prevalent and causing adverse impacts on the beneficial use of ground water resources throughout the state.

Table 49. Major Sources of Ground Water Contamination in North Dakota

CONTAMINANT SOURCE	TEN HIGHEST PRIORITY SOURCES (✓)	FACTORS CONSIDERED IN SELECTING A CONTAMINANT SOURCE ⁽¹⁾	CONTAMINANTS ⁽²⁾
Agricultural Activities			
Agricultural chemical facilities	✓	A,D,C	B,E
Animal feedlots	✓	A,D	E,J
Drainage wells			
Fertilizer applications			
Irrigation practices			
Pesticide applications			
Storage and Treatment Activities			
Land application			
Material stockpiles			
Storage tanks (above ground)	✓	A,D,C	D
Storage tanks (underground)	✓	A,D,C	D
Surface impoundments	✓	D	G
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	✓	A,D	C,E,H
Septic systems			
Shallow injection wells			
Other			
Hazardous waste generators			
Hazardous waste sites			
Industrial facilities	✓	A,D	C,H
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			

CONTAMINANT SOURCE	TEN HIGHEST PRIORITY SOURCES (✓)	FACTORS CONSIDERED IN SELECTING A CONTAMINANT SOURCE ⁽¹⁾	CONTAMINANTS ⁽²⁾
Salt storage and road salting			
Salt water intrusion			
Spills	✓	A	B,C,D,E,G
Transportation of materials			
Urban runoff			
Other sources (please specify)			
Other sources (please specify)			
⁽¹⁾ Factors considered in selecting a contaminant source - latter designation indicated by order of importance in the above column: A. Human health and/or environmental risk (toxicity) B. Size of the population at risk C. Location of the sources relative to drinking water sources D. Number and/or size of contaminant sources E. Hydrogeologic sensitivity F. State findings, other findings G. Other criteria (Please add or describe in the narrative.)			
⁽²⁾ Contaminants associated with each factor from previous column: A. Inorganic pesticides B. Organic pesticides C. Halogenated solvents D. Petroleum compounds E. Nitrate F. Fluoride G. Salinity/brine H. Metals I. Radionuclides J. Bacteria K. Protozoa L. Viruses M. Other (Please add or describe in the narrative.)			

Aquifer Vulnerability

To determine where to spend the limited financial and human resources required to implement ground water assessment and protection activities, the Health Department's Division of Water Quality developed the GTS. The GTS was developed in 1992, in an effort to prioritize aquifers in order of their susceptibility to contamination. This prioritization system is currently used to target aquifer systems for increased protection, education, and monitoring activities.

The GTS was completed using a modified DRASTIC Ground Water Vulnerability Model to calculate the relative aquifer vulnerability score based upon:

- D - Depth to Water
- R - Recharge
- A - Aquifer Media
- S - Soil Media
- T - Topography
- I - Impact of the Vadose Zone
- C - Conductivity

In addition to the above-referenced parameters, ground water appropriation and a land use surrogate to identify potential agricultural chemical use were added to the evaluation system. Each aquifer was evaluated as a discrete whole unit if all portions of the aquifer had similar characteristics, or it was subdivided into sub-aquifer units of similar hydrogeologic characteristics. The GTS evaluation does not identify critical recharge areas or areas where special management practices must be applied. Rather, the evaluation identifies aquifer settings where an increased contamination potential exists. Aquifers identified as having an elevated potential for ground water contamination are highlighted as requiring increased assessment and educational activities relating to ground water quality protection.

Figure 12 shows the total monitoring scores for identifying the relative vulnerability of major glacial drift aquifers located in the state. Table 50 lists the top 50 most vulnerable aquifer systems according to the GTS, in order from most to least vulnerable.

Figure 12. Total Monitoring Scores for Major Glacial Drift Aquifers in North Dakota

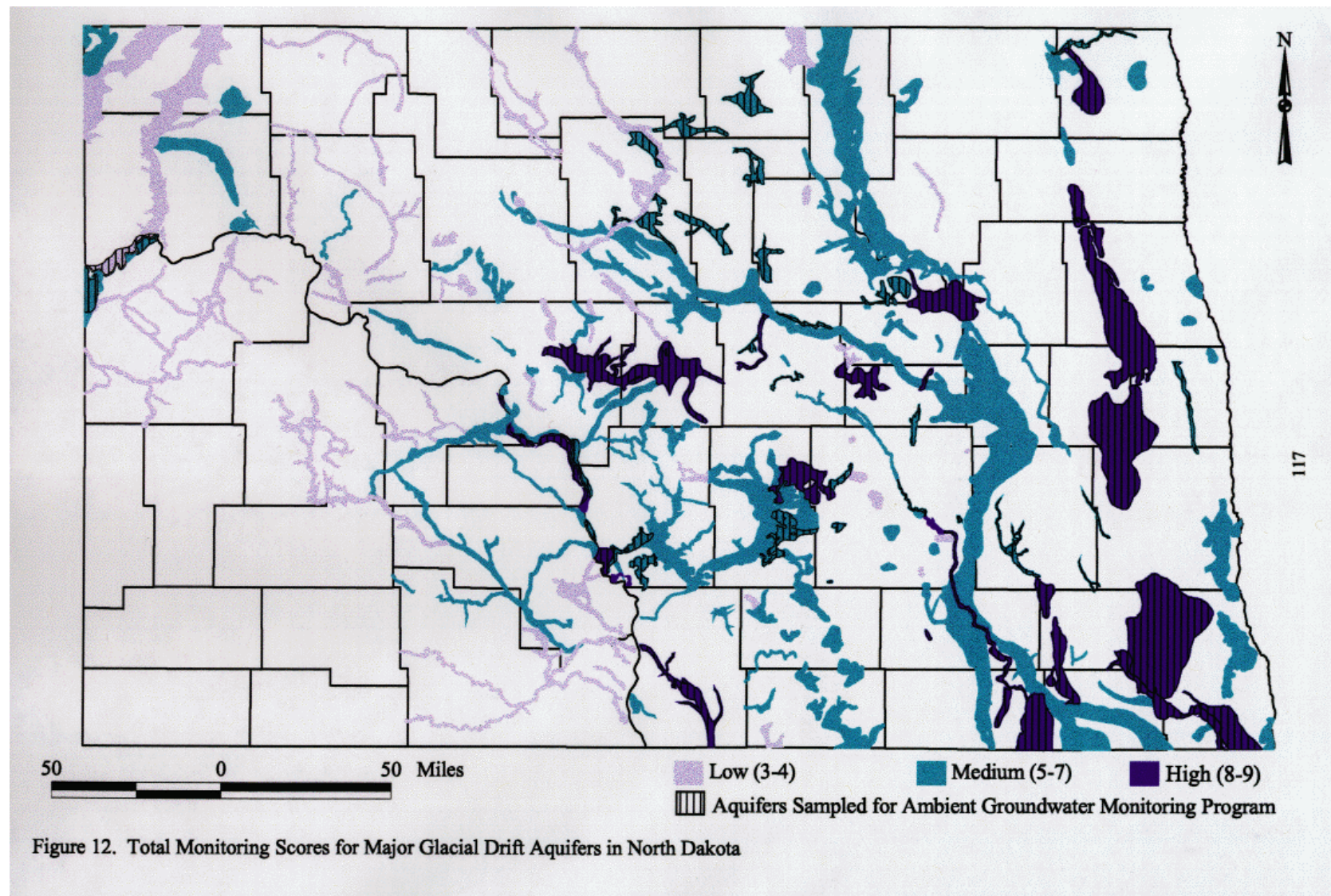


Figure 12. Total Monitoring Scores for Major Glacial Drift Aquifers in North Dakota

Table 50. Fifty Most Vulnerable Aquifer Systems

North Dakota Geographic Targeting System Scoring Ranked by Total Monitoring Score
(2/25/94)

RANK	AQUIFER NAME	DRASTIC SCORE	PEST. DRASTIC SCORE	CHEM. USE SURROGATE (\$/AC)	PERMITTED WATER USE (AC FT/YR)	TOTAL MONITORING SCORE
1	Elk Valley	167	189 (High)	112.90 (High)	14412 (High)	9 (High)
2	Oakes	161	185 (High)	75.00 (High)	19083 (High)	9 (High)
3	Sheyenne Delta	153	182 (High)	131.04 (High)	13902 (High)	9 (High)
4	Inkster	157	179 (High)	112.90 (High)	3587 (High)	9 (High)
5	Icelandic	140	177 (High)	154.00 (High)	1210 (High)	9 (High)
6	Fordville	155	167 (High)	144.71 (High)	2703 (High)	9 (High)
7	Galesburg/Page	144	163 (High)	75.44 (High)	13920 (High)	9 (High)
8	Warwick	156	187 (High)	46.78 (Mod.)	2640 (High)	8 (High)
9	Juanita Lake	169	186 (High)	75.50 (High)	1016 (Mod.)	8 (High)
10	Hankinson	149	185 (High)	131.04 (High)	966 (Mod.)	8 (High)
11	Sand Prairie	159	181 (High)	67.26 (High)	1102 (Mod.)	8 (High)
12	Edgeley	172	181 (High)	71.55 (High)	801.7 (Mod.)	8 (High)
13	Marstonmoor Plain	162	180 (High)	45.00 (Mod.)	4321 (High)	8 (High)
14	Medford	147	174 (High)	128.81 (High)	601.7 (Mod.)	8 (High)
15	Strasburg	160	169 (High)	52.56 (Mod.)	1766 (High)	8 (High)
16	Lake Nettie Aq. System	160	169 (High)	40.24 (Mod.)	6749 (High)	8 (High)
17	Wagonsport	154	165 (High)	41.91 (Mod.)	1221 (High)	8 (High)
18	Manfred	142	165 (High)	60.11 (High)	200 (Mod.)	8 (High)
19	Bismarck	145	163 (High)	41.91 (Mod.)	2499 (High)	8 (High)
20	Milnor Channel	134	156 (Mod.)	131.04 (High)	8339 (High)	8 (High)
21	Englevale	130	155 (Mod.)	76.46 (High)	19786 (High)	8 (High)
22	LaMoure	126	149 (Mod.)	71.69 (High)	8515 (High)	8 (High)
23	Guelph	118	139 (Mod.)	71.69 (High)	2074 (High)	8 (High)
24	Carrington	109	130 (Mod.)	75.50 (High)	7434 (High)	8 (High)
25	Rocky Run	165	187 (High)	60.11 (High)	0 (Low)	7 (Mod.)
26	Tower City	160	179 (High)	123.67 (High)	67.0 (Low)	7 (Mod.)
27	Kilgore	144	179 (High)	41.30 (Mod.)	210 (Mod.)	7 (Mod.)
28	James River	161	179 (High)	75.50 (High)	54.0 (Low)	7 (Mod.)
29	Heimdal	161	179 (High)	60.11 (High)	0 (Low)	7 (Mod.)

Table 50. (cont.) Fifty Most Vulnerable Aquifer Systems

RANK	AQUIFER NAME	DRASTIC SCORE	PEST. DRASTIC SCORE	CHEM. USE SURROGATE (\$/AC)	PERMITTED WATER USE (AC FT/YR)	TOTAL MONITORING SCORE
30	Stoney Slough	155	174 (High)	67.26 (High)	0 (Low)	7 (Mod.)
31	Pipestem Creek	154	173 (High)	60.11 (High)	89 (Low)	7 (Mod.)
32	Rusland	148	169 (High)	60.11 (High)	0 (Low)	7 (Mod.)
33	Medina	161	169 (High)	58.68 (Mod.)	400 (Mod.)	7 (Mod.)
34	Shell Valley	146	168 (High)	39.45 (Low)	1826 (High)	7 (Mod.)
35	Seven Mile Coulee	148	167 (High)	58.68 (Mod.)	1075 (Mod.)	7 (Mod.)
36	Tokio	157	166 (High)	45.86 (Mod.)	712 (Mod.)	7 (Mod.)
37	Burnt Creek	137	159 (Mod.)	41.91 (Mod.)	3412 (High)	7 (Mod.)
38	Streeter	144	157 (Mod.)	58.68 (Mod.)	3368 (High)	7 (Mod.)
39	Horseshoe Valley	152	156 (Mod.)	40.85 (Mod.)	3582 (High)	7 (Mod.)
40	Esmond	134	156 (Mod.)	45.86 (Mod.)	1439 (High)	7 (Mod.)
41	Glencoe Channel	128	149 (Mod.)	41.94 (Mod.)	1371 (High)	7 (Mod.)
42	Bantel	123	147 (Mod.)	123.67 (High)	670.5 (Mod.)	7 (Mod.)
43	Painted Woods Lake	133	145 (Mod.)	40.85 (Mod.)	2098 (High)	7 (Mod.)
44	Pembina River	116	139 (Mod.)	154.07 (High)	1011 (Mod.)	7 (Mod.)
45	Apple Creek - Lower	114	137 (Mod.)	41.91 (Mod.)	2819 (High)	7 (Mod.)
46	Hillsboro	116	135 (Mod.)	127.32 (High)	430 (Mod.)	7 (Mod.)
47	Spiritwood Aq. System	90	128 (Low)	61.52 (High)	30975 (High)	7 (Mod.)
48	Ellendale	100	124 (Low)	71.69 (High)	1513 (High)	7 (Mod.)
49	West Fargo	75	95 (Low)	123.67 (High)	5286 (High)	7 (Mod.)
50	Goldwin	175	196 (High)	58.68 (Mod.)	0 (Low)	6 (Mod.)

In an effort to assess the impact of contaminants on specific aquifers, the top five most vulnerable aquifer systems (as defined by the GTS) were evaluated with respect to potential contaminant sources and application of pollution control programs within the aquifers' boundaries. The five aquifers selected for this report are: 1) Inkster, 2) Elk Valley, 3) Oakes, 4) Icelandic, and 5) Sheyenne Delta. Figures 13-17 show maps of each aquifer system. Their associated contaminant evaluations are presented in Tables 51-55.

Figure 13. Inkster and Elk Valley Aquifers

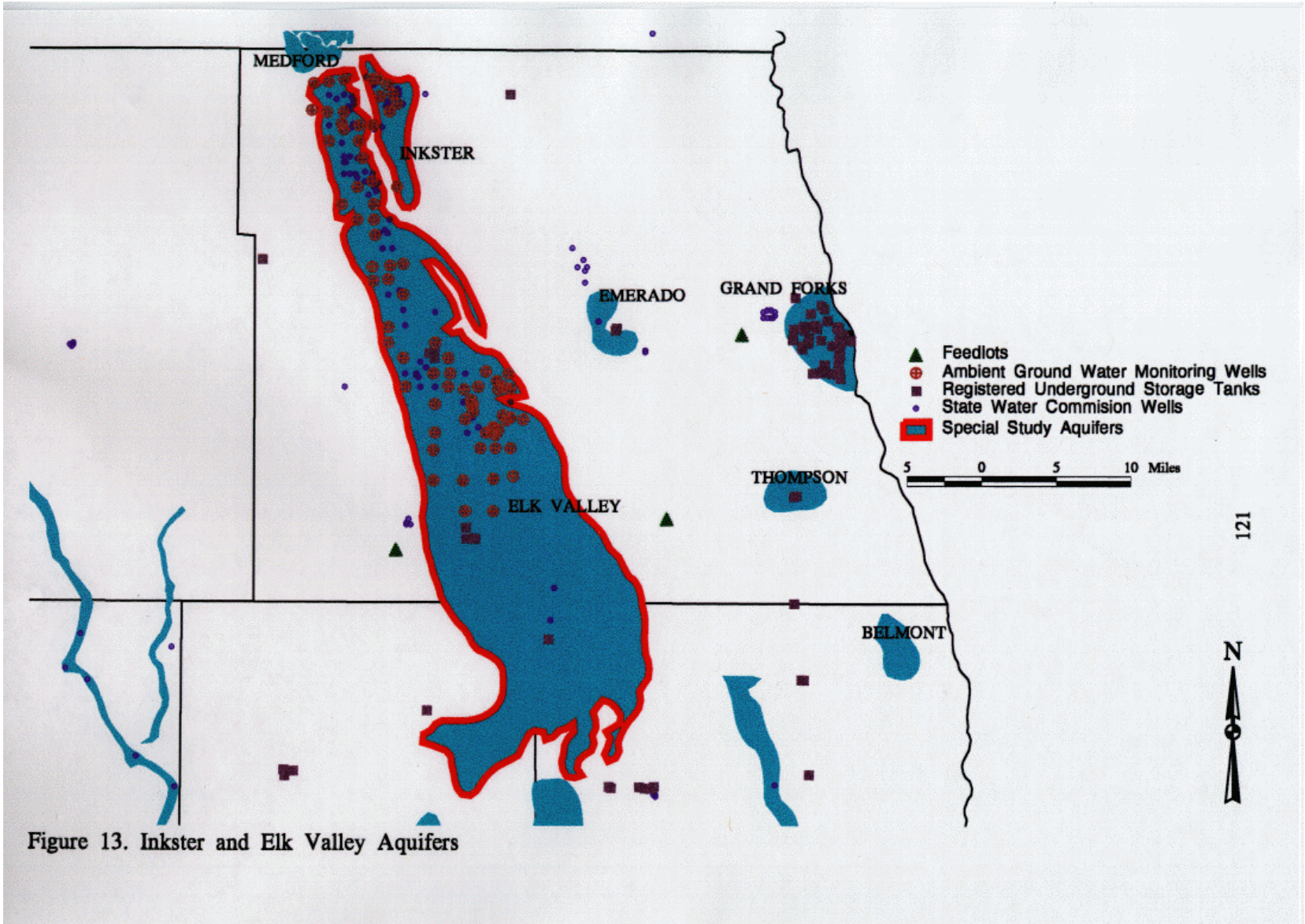


Table 51. Ground Water Contamination Summary - Inkster Aquifer

Aquifer Description: Inkster Aquifer County(ies) (optional): Grand Forks Aquifer
Setting: Sand and Gravel - Rural Longitude/Latitude (optional): _____
Data Reporting Period: _____

SOURCE TYPE	PRESENT IN REPORTING AREA (circle)	NO. OF SITES IN AREA	NO. OF SITES THAT ARE LISTED AND/OR HAVE CONFIRMED RELEASES	NO. WITH CONFIRMED GROUND WATER CONTAMINATION	CONTAMINANTS	NO. OF SITE INVESTIGATIONS (optional)	NO. OF SITES THAT HAVE BEEN STABILIZED OR HAVE HAD THE SOURCE REMOVED (optional)	NO. OF SITES WITH CORRECTIVE ACTION PLANS (optional)	NO. OF SITES WITH ACTIVE REMEDIATION (optional)	NO. OF SITES WITH CLEANUP COMPLETED (optional)
NPL	Yes / No									
CERCLIS (non-NPL)	Yes / No									
DOD/DOE	Yes / No									
LUST	Yes / No	2	0							
RCRA Corrective Action	Yes / No									
Underground Injection	Yes / No									
State Sites	Yes / No									
Nonpoint Sources	Yes / No									
Other (specify)	Yes / No									
Totals		2	0							

NPL:	National Priority List
CERCLIS (non-NPL):	Comprehensive Environmental Response, Compensation, and Liability Information System
DOE:	Department of Energy
DOD:	Department of Defense
LUST:	Leaking Underground Storage Tanks
RCRA:	Resource Conservation and Recovery Act

Table 52. Ground Water Contamination Summary - Elk Valley

Aquifer Description: Elk Valley County(ies) (optional): Grand Forks / Trail / Steele Aquifer
 Setting: Sand and Gravel - Rural Longitude/Latitude (optional): _____
 Data Reporting Period: _____

	PRESENT IN		NO. OF SITES THAT ARE LISTED	NO. WITH CONFIRMED	CONTAMINANTS	NO. OF SITE INVESTIGATIONS	NO. OF SITES THAT HAVE BEEN	NO. OF SITES WITH	NO. OF SITES WITH ACTIVE	NO. OF SITES WITH
NPL	Yes / No	--								
CERCLIS (non-NPL)	Yes / No	--								
DOD/DOE	Yes / No	--								
LUST	Yes / No	36	1		Petroleum					
RCRA Corrective Action	Yes / No	--								
Underground Injection ***	Yes / No	8	0	0		0				
State Sites	Yes / No									
Nonpoint Sources **	Yes / No	Est. 5	1	?	Nitrate					
Other (specify) *	Yes / No	Est. 15	6	3	Petroleum	6	3	3	1	--
Totals		64	8	3		6	3	3	1	

NPL:

CERCLIS (non-NPL):

DOE:

DOD:

LUST:

National Priority List

Comprehensive Environmental Response, Compensation, and Liability Information System

Department of Energy

Department of Defense

Leaking Underground Storage Tanks

*: ASTs and Accidental Releases

**: Feedlots

***: 5 x 28 and SWII Wells

Figure 14. Oakes Aquifer

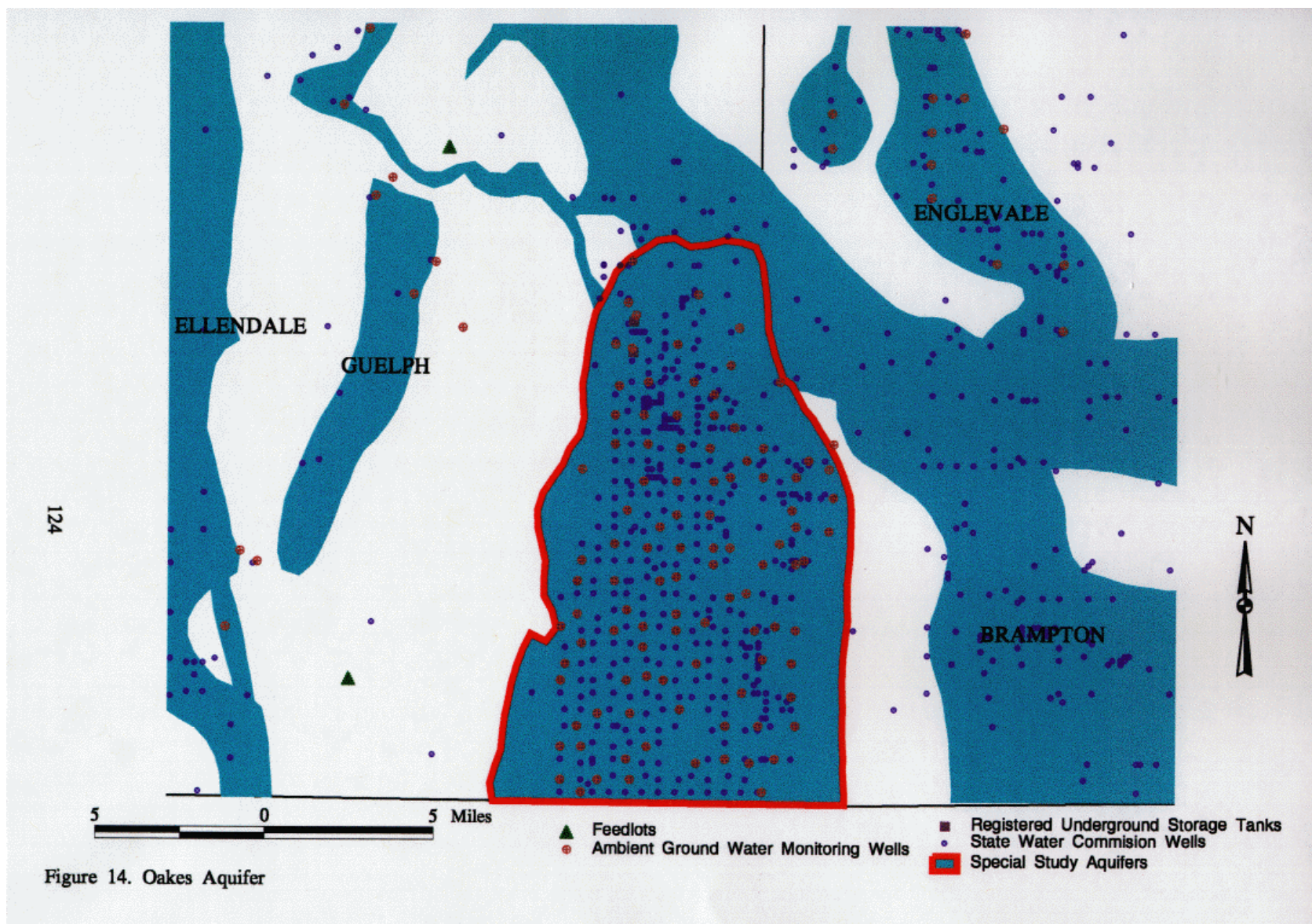


Table 53. Ground Water Contamination Summary - Oakes Aquifer

Aquifer Description: Oakes Aquifer County(ies) (optional): Dickey / Sargent
 Aquifer Setting: Sand and Gravel - Rural Longitude/Latitude (optional): _____
 Data Reporting Period: _____

SOURCE TYPE	PRESENT IN REPORTING AREA (circle)	NO. OF SITES IN AREA	NO. OF SITES THAT ARE LISTED AND/OR HAVE CONFIRMED RELEASES	NO. WITH CONFIRMED GROUND WATER CONTAMINATION	CONTAMINANTS	NO. OF SITE INVESTIGATIONS (optional)	NO. OF SITES THAT HAVE BEEN STABILIZED OR HAVE HAD THE SOURCE REMOVED (optional)	NO. OF SITES WITH CORRECTIVE ACTION PLANS (optional)	NO. OF SITES WITH ACTIVE REMEDIATION (optional)	NO. OF SITES WITH CLEANUP COMPLETED (optional)
NPL	Yes / No	--								
CERCLIS (non-NPL)	Yes / No	--								
DOD/DOE	Yes / No	--								
LUST	Yes / No	24	0	0	Petroleum					
RCRA Corrective Action	Yes / No	--								
Underground Injection ***	Yes / No	6	0	0						
State Sites	Yes / No	--								
Nonpoint Sources **	Yes / No	Est. 5	2	1	Nitrate					
Other (specify) *	Yes / No	Est. 2	1	--						
Totals		37	3	1						

NPL:
 CERCLIS (non-NPL):
 DOE:
 DOD:
 LUST:

National Priority List
 Comprehensive Environmental Response, Compensation, and Liability Information System
 Department of Energy
 Department of Defense
 Leaking Underground Storage Tanks

*: Fertilizer Storage Facility
 **: Feedlot/Irrigation
 ***: 5 x 28 and SWII

Figure 15. Icelandic Aquifer

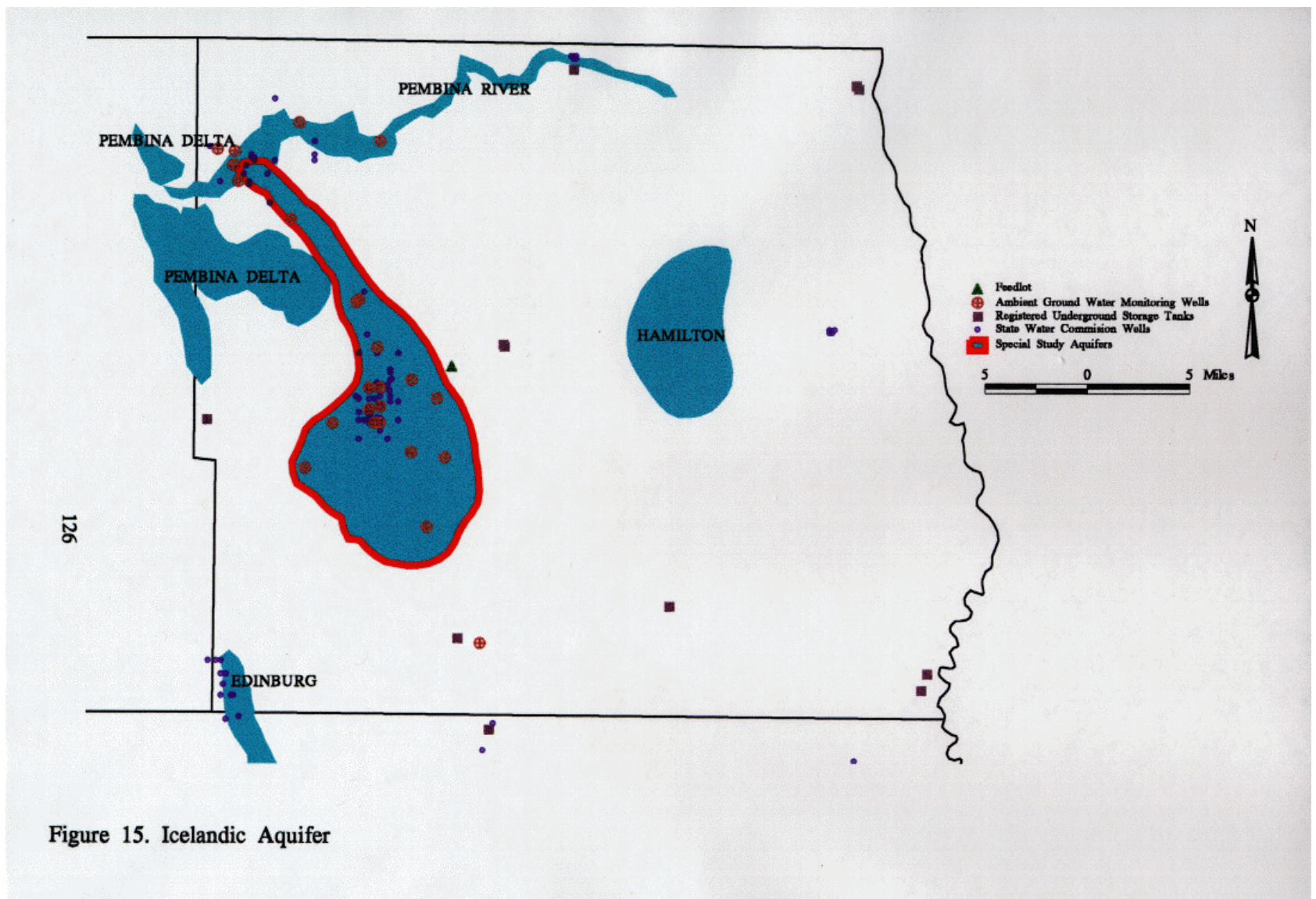


Table 54. Ground Water Contamination Summary - Icelandic Aquifer

Aquifer Description: Icelandic Aquifer
 Aquifer Setting: Sand and Gravel - Rural

County(ies) (optional): Pembina
 Longitude/Latitude (optional): _____
 Data Reporting Period: _____

SOURCE TYPE	PRESENT IN REPORTING AREA (circle)	NO. OF SITES IN AREA	NO. OF SITES THAT ARE LISTED AND/OR HAVE CONFIRMED RELEASES	NO. WITH CONFIRMED GROUND WATER CONTAMINATION	CONTAMINANTS	NO. OF SITE INVESTIGATIONS (optional)	NO. OF SITES THAT HAVE BEEN STABILIZED OR HAVE HAD THE SOURCE REMOVED (optional)	NO. OF SITES WITH CORRECTIVE ACTION PLANS (optional)	NO. OF SITES WITH ACTIVE REMEDIATION (optional)	NO. OF SITES WITH CLEANUP COMPLETED (optional)
NPL	Yes / No									
CERCLIS (non-NPL)	Yes / No									
DOD/DOE	Yes / No									
LUST	Yes / No	10	1	1	Petroleum	1	1			
RCRA Corrective Action	Yes / No									
Underground Injection	Yes / No	6	--							
State Sites	Yes / No									
Nonpoint Sources	Yes / No									
Other (specify) *	Yes / No	Est. 10	2	1	Petroleum					
Totals		26	2	1		1	1			

NPL:
 CERCLIS (non-NPL):
 DOE:
 DOD:
 LUST:
 RCRA:

National Priority List
 Comprehensive Environmental Response, Compensation, and Liability Information System
 Department of Energy
 Department of Defense
 Leaking Underground Storage Tanks
 Resource Conservation and Recovery Act

*: ASTs

Figure 16. Sheyenne Delta Aquifer

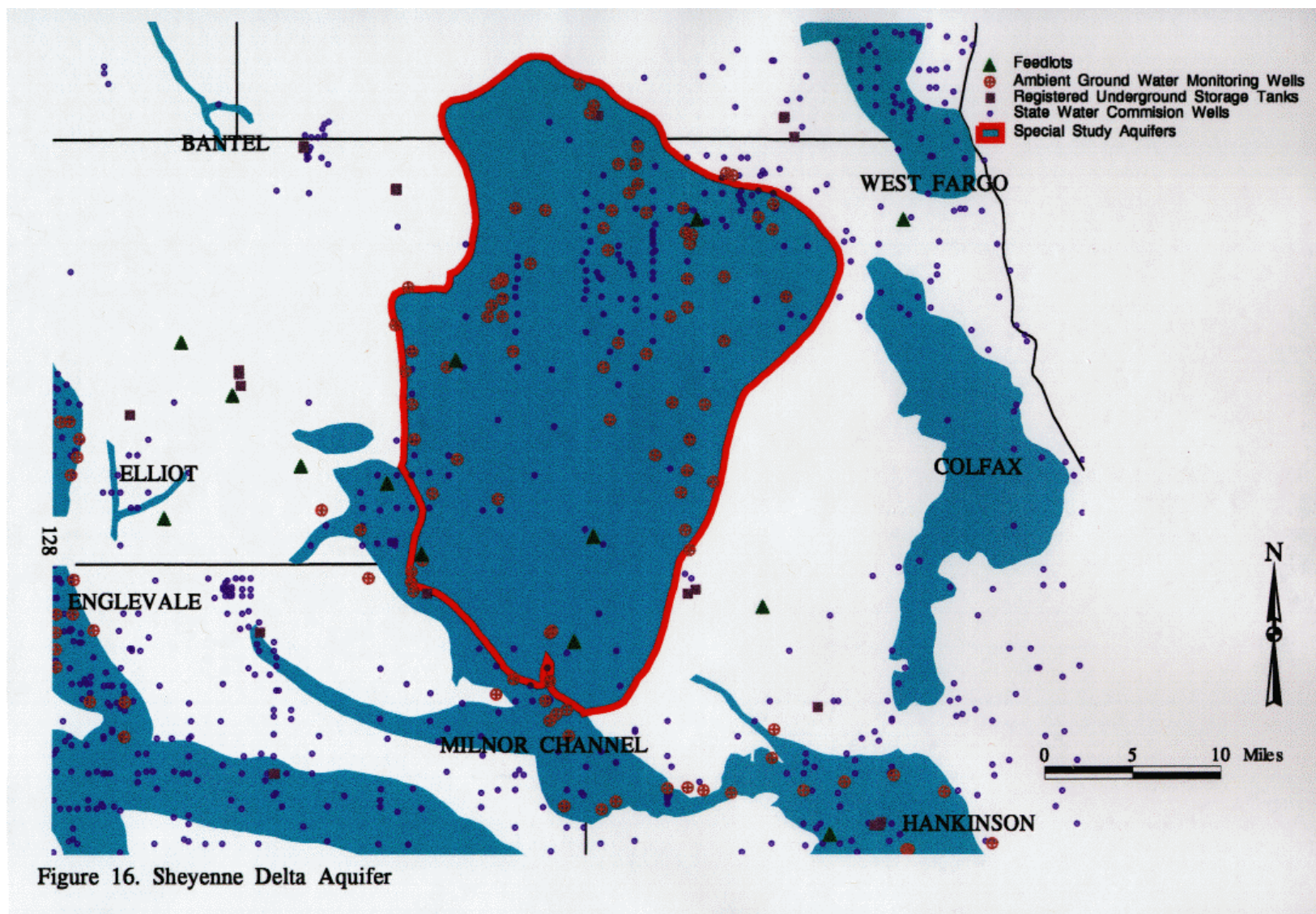


Table 55. Ground Water Contamination Summary - Sheyenne Delta Aquifer

Aquifer Description: Sheyenne Delta
 Aquifer Setting: Sand and Gravel - Rural

County(ies) (optional): Richland / Sargent / Ransom
 Longitude/Latitude (optional): _____
 Data Reporting Period: _____

COURSE	PRESENT IN REPORTING PERIOD	NO. OF SITES	NO. OF SITES THAT ARE LISTED AND/OR HAVE	NO. WITH CONFIRMED GROUND WATER	CONTAMINANTS	NO. OF SITE INVESTIGATIONS (optional)	NO. OF SITES THAT HAVE BEEN STABILIZED OR	NO. OF SITES WITH CORRECTIVE	NO. OF SITES WITH ACTIVE REMEDIATION	NO. OF SITES WITH CLEANUP
NPL	Yes / No	--								
CERCLIS (non-NPL)	Yes / No	--								
DOD/DOE	Yes / No	--								
LUST	Yes / No	7	2	2	Petroleum	2	1		1	
RCRA Corrective Action	Yes / No	--								
Underground Injection *	Yes / No	1								
State Sites	Yes / No	--								
Nonpoint Sources **	Yes / No	1	1	1	Nitrates					
Other (specify) ***	Yes / No	Est. 2			Petroleum Arsenic					
Totals		11	3	3		2	1		1	

NPL: National Priority List
 CERCLIS (non-NPL): Comprehensive Environmental Response, Compensation, and Liability Information System
 DOE: Department of Energy
 DOD: Department of Defense
 LUST: Leaking Underground Storage Tanks

*: 5 x 28 Class V
 **: Feedlots
 ***: Arsenic Trioxide Superfund Site/Accidental Releases

Ground Water Protection Programs

In 1967, North Dakota enacted legislation enabling state regulation of activities which have caused or which have the potential to cause adverse impacts on the quality of the waters of the state. NDCC 61-28 entitled, "Control, Prevention and Abatement of Pollution of Surface Waters," not only defines the statement of policy for surface and ground water quality protection, but also sets specific prohibitions and penalties for violation of the state law. Since the enactment of NDCC 61-28, the state has pursued a policy to:

"...act in the public interest to protect, maintain, and improve the quality of the waters of the state for continued use as public and private water supplies, propagation of wildlife, fish and aquatic life and for domestic, agricultural, industrial and recreational and other legitimate beneficial uses...."

North Dakota has historically envisioned ground water quality protection to include a mix of financial and technical cooperation between federal, state, and local governmental and private agencies. Since the early 1970s, the Health Department has continued to build upon existing ground water protection capacities through the attainment of primacy for some federal programs or through cooperative working relationships with other state, federal, and local entities. Table 56 identifies a summary of Ground Water Protection Programs in North Dakota.

Recent activities designed to enhance the protection of the state's ground water quality have included implementing rules for construction and abandonment of monitoring wells, and evaluating the need to develop ground water quality standards. However, due to the difficulty in attaining public consensus, the need to develop numeric ground water quality standards is being reexamined.

Major future issues requiring a multi-agency cooperative effort include:

1. Providing to the public electronic access to all ground water quality monitoring information. This will include information collected and maintained by all state, federal, and local agencies conducting work in the state.
2. Resolving multi-agency issues relating to the appropriation and use of water resources and the potential impacts on water quality.
3. Encouraging cooperative protection efforts with federal, state, local, and tribal governments as they relate to ground water quality issues in North Dakota.

Table 56. North Dakota Summary of State Ground Water Protection Programs

PROGRAMS OR ACTIVITIES	CHECK (✓)	IMPLEMENTATION STATUS	RESPONSIBLE STATE AGENCY
Active SARA Title III Program	✓	Established	Emergency Management
Ambient Ground Water Monitoring System	✓	Established	NDDH / NDSWC
Aquifer Vulnerability Assessment	✓	Established	NDDH
Aquifer Mapping	✓	Established	NDSWC
Aquifer Characterization	✓	Established	NDSWC
Comprehensive Data Management System			
EPA-Endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)			
Ground Water Discharge Permits			
Ground Water Best Management Practices			
Ground Water Legislation	✓	Established	NDDH
Ground Water Classification	✓	Established	NDDH
Ground Water Quality Standards			
Interagency Coordination for Ground Water Protection Initiatives			
Nonpoint Source Controls			
Pesticide State Management Plan	✓	Under Development	NDAG
Pollution Prevention Program	✓	Established	NDDH
Resource Conservation and Recovery Act (RCRA) Primacy	✓	Established	NDDH
State Superfund			
State RCRA Program Incorporating More Stringent Requirements than RCRA Primacy			
State Septic System Regulations			
Underground Storage Tank Installation Requirements	✓	Established	NDDH
Underground Storage Tank Remediation Fund	✓	Established	NDID
Underground Storage Tank Permit Program	✓	Established	NDDH
Underground Injection Control Program	✓	Established	NDDH
Vulnerability Assessment for Drinking Water/Wellhead Protection	✓	Established	NDDH
Well Abandonment Regulations	✓	Established	NDDH / NDSWC
Wellhead Protection Program (EPA-Approved)	✓	Established	NDDH
Well Installation Regulations	✓	Established	NDDH
<p>ABBREVIATIONS: NDDH = North Dakota Department of Health NDSWC = North Dakota State Water Commission NDAG = North Dakota Agriculture Department NDID = North Dakota Insurance Department</p>			

Ground Water Quality

Ambient Ground Water Quality Monitoring

Ambient ground water quality monitoring activities are conducted by several state agencies, with the primary activities being conducted by the SWC and the Health Department. The monitoring programs have been developed to assess ground water quality and/or quantity in the major aquifer systems located throughout the state. Monitoring conducted by the department is designed to evaluate the condition of ground water quality as it relates to inorganic/organic chemical constituents and the occurrence of selected agricultural chemical compounds. Additional water quality information is developed as part of the Safe Drinking Water Act requirements through the monitoring of public drinking water supply systems.

In 1992, the department's Division of Water Quality initiated an ambient ground water monitoring program to determine the occurrence of 50 selected agricultural pesticides in the 50 most vulnerable aquifer systems within a 5-year period. Sample locations are determined using a selection process, which considers well construction integrity, well location, and the presence of water treatment systems. Since its initiation in 1992, approximately 760 wells in the 50 most vulnerable aquifer systems have been monitored. Tables 57-61 provide a general indication of water quality as it relates to synthetic organic chemical and nitrate detections in selected aquifer systems.

Future improvements to the ambient ground water quality monitoring program will include:

1. Constructing or locating of additional monitoring points in aquifer systems with limited monitoring locations.
2. Geo-referencing all ground water monitoring locations.
3. Monitoring the remaining "less vulnerable" aquifer systems during the next 15 years, while maintaining the 5-year monitoring cycle for the 50 most vulnerable systems.

Future commitment to the ambient ground water monitoring program will depend upon funding and availability of staff.

Table 57. Aquifer Monitoring Data - Inkster Aquifer

Aquifer Description Inkster Aquifer County(ies) (optional) Grand Forks
 Aquifer Setting Red River Valley Longitude/Latitude (optional) 48° 07' N 97° 40' W
 Data Reporting Period *

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells									
			No detections of parameters above MDLs or background levels		No detections of parameters above MDLs or background levels and nitrate concentrations range from background levels to less than or equal to 5 mg/l		Parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs and/or nitrate ranges from greater than 5 to less than or equal to 10 mg/l	Parameters are detected at concentrations exceeding the MCLs	Removed from service	Special treatment	Background parameters exceed MCLs	
			ND	No. of wells in sensitive or vulnerable areas (opt)	ND/Nitrate ≤ 5 mg/l	No. of wells in sensitive or vulnerable areas (opt)						
Ambient Monitoring Network (Optional)	9	VOC	Not sampled for									
		SOC	9	9	0	0	0	0	0	0	0	
		NO ₃	8	8	0	0	1	0	0	0	0	
		Other										
Raw Water Quality Data from Public Water Supply Wells	**	VOC										
		SOC										
		NO ₃										
		Other										
Finished Water Quality Data from Public Water Supply Wells	3	VOC	3	3	0	0	0	0	0	0	0	
		SOC	3	3	0	0	0	0	0	0	0	
		NO ₃	3	3	0	0	0	0	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Private or Unregulated Wells		VOC										
		SOC										
		NO ₃										
		Other										
Other Sources (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Major uses of the aquifer or hydrologic unit (Optional)			<input checked="" type="checkbox"/> Public water supply <input checked="" type="checkbox"/> Private water supply		<input checked="" type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
Uses affected by water quality problems (Optional)			<input type="checkbox"/> Public water supply <input type="checkbox"/> Private water supply		<input type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
* Ambient Monitoring: 6/93 - 5/94. Public Water Supply Data: 1993-1995												
** No data available.												

Table 58. Aquifer Monitoring Data - Elk Valley

Aquifer Description Elk Valley County(ies) (optional) Grand Forks / Traill / Steele
 Aquifer Setting Red River Valley Longitude/Latitude (optional) 47° 55' N 97° 37' W
 Data Reporting Period *

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells									
			No detections of parameters above MDLs or background levels		No detections of parameters above MDLs or background levels and nitrate concentrations range from background levels to less than or equal to 5 mg/l		Parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs and/or nitrate ranges from greater than 5 to less than or equal to 10 mg/l	Parameters are detected at concentrations exceeding the MCLs	Removed from service	Special treatment	Background parameters exceed MCLs	
			ND	No. of wells in sensitive or vulnerable areas (opt)	ND/Nitrate ≤ 5 mg/l	No. of wells in sensitive or vulnerable areas (opt)						
Ambient Monitoring Network (Optional)	56	VOC	Not sampled for									
		SOC	49	49	11	11	7	0	0	0	0	
		NO ₃	44	44	11	11	0	1	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Public Water Supply Wells	**	VOC										
		SOC										
		NO ₃										
		Other										
Finished Water Quality Data from Public Water Supply Wells	24	VOC	24					0	0	0	0	
		SOC					2 ***	0	0	0	0	
		NO ₃	24					0	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Private or Unregulated Wells		VOC										
		SOC										
		NO ₃										
		Other										
Other Sources (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Major uses of the aquifer or hydrologic unit (Optional)			<input checked="" type="checkbox"/> Public water supply	<input checked="" type="checkbox"/> Private water supply	<input checked="" type="checkbox"/> Irrigation	<input type="checkbox"/> Thermoelectric	<input type="checkbox"/> Commercial Livestock	<input type="checkbox"/> Mining Industrial	<input type="checkbox"/> Baseflow Maintenance			
Uses affected by water quality problems (Optional)			<input type="checkbox"/> Public water supply	<input type="checkbox"/> Private water supply	<input type="checkbox"/> Irrigation	<input type="checkbox"/> Thermoelectric	<input type="checkbox"/> Commercial Livestock	<input type="checkbox"/> Mining Industrial	<input type="checkbox"/> Baseflow Maintenance			
* Ambient monitoring - 6/93-5/94; PWS data - 1993-1995. ** No data available												

Table 59. Aquifer Monitoring Data - Oakes Aquifer

Aquifer Description Oakes Aquifer County(ies) (optional) Dickey / Sargent
 Aquifer Setting Central Lowlands Phys. Province Longitude/Latitude (optional) 46° 08' N 98 ° 05' W
 Data Reporting Period *

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells									
			No detections of parameters above MDLs or background levels		No detections of parameters above MDLs or background levels and nitrate concentrations range from background levels to less than or equal to 5 mg/l		Parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs and/or nitrate ranges from greater than 5 to less than or equal to 10 mg/l	Parameters are detected at concentrations exceeding the MCLs	Removed from service	Special treatment	Background parameters exceed MCLs	
			ND	No. of wells in sensitive or vulnerable areas (opt)	ND/Nitrate ≤ 5 mg/l	No. of wells in sensitive or vulnerable areas (opt)						
Ambient Monitoring Network (Optional)	103	VOC	Not sampled for									
		SOC	102	102	14	14	1	0	0	0	0	
		NO ₃	84	84	14	14	2	3	0	0	0	
		Other										
Raw Water Quality Data from Public Water Supply Wells	**	VOC										
		SOC										
		NO ₃										
		Other										
Finished Water Quality Data from Public Water Supply Wells	3	VOC	3	3	0	0	0	0	0	0	0	
		SOC	3	3	0	0	0	0	0	0	0	
		NO ₃	3	3	0	0	0	0	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Private or Unregulated Wells (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Other Sources (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Major uses of the aquifer or hydrologic unit (Optional)			<input checked="" type="checkbox"/> Public water supply	<input checked="" type="checkbox"/> Private water supply	<input checked="" type="checkbox"/> Irrigation	<input type="checkbox"/> Thermoelectric	<input type="checkbox"/> Commercial	<input type="checkbox"/> Livestock	<input type="checkbox"/> Mining	<input type="checkbox"/> Industrial	<input checked="" type="checkbox"/> Baseflow	<input type="checkbox"/> Maintenance
Uses affected by water quality problems (Optional)			<input type="checkbox"/> Public water supply	<input type="checkbox"/> Private water supply	<input type="checkbox"/> Irrigation	<input type="checkbox"/> Thermoelectric	<input type="checkbox"/> Commercial	<input type="checkbox"/> Livestock	<input type="checkbox"/> Mining	<input type="checkbox"/> Industrial	<input type="checkbox"/> Baseflow	<input type="checkbox"/> Maintenance
* Ambient monitoring: Summer 1992. Public Water Supply Data: 1993-1995												
** No data available.												

Table 60. Aquifer Monitoring Data - Icelandic Aquifer

Aquifer Description Icelandic Aquifer County(ies) (optional) Pembina
 Aquifer Setting Red River Valley Longitude/Latitude (optional) 48° 45' N 97° 45' W
 Data Reporting Period *

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells									
			No detections of parameters above MDLs or background levels		No detections of parameters above MDLs or background levels and nitrate concentrations range from background levels to less than or equal to 5 mg/l		Parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs and/or nitrate ranges from greater than 5 to less than or equal to 10 mg/l	Parameters are detected at concentrations exceeding the MCLs	Removed from service	Special treatment	Background parameters exceed MCLs	
			ND	No. of wells in sensitive or vulnerable areas (opt)	ND/Nitrate ≤ 5 mg/l	No. of wells in sensitive or vulnerable areas (opt)						
Ambient Monitoring Network (Optional)	18	VOC	Not sampled for									
		SOC	17	17	7	7	1	0	0	0	0	
		NO ₃	7	7	7	7	1	3	0	0	0	
		Other										
Raw Water Quality Data from Public Water Supply Wells	**	VOC										
		SOC										
		NO ₃										
		Other										
Finished Water Quality Data from Public Water Supply Wells	22	VOC	21	21	0	0	1	0	0	0	0	
		SOC	22	22	0	0	0	0	0	0	0	
		NO ₃	22	22	0	0	0	0	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Private or Unregulated Wells (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Other Sources (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Major uses of the aquifer or hydrologic unit (Optional)			<input checked="" type="checkbox"/> Public water supply <input checked="" type="checkbox"/> Private water supply		<input checked="" type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
Uses affected by water quality problems (Optional)			<input type="checkbox"/> Public water supply <input type="checkbox"/> Private water supply		<input type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
* Ambient Monitoring: Summer 1992. Public Water Supply Data: 1993-1995.												
** No data available.												

Table 61. Aquifer Monitoring Data - Sheyenne Delta

Aquifer Description Sheyenne Delta County(ies) (optional) Richland / Ransom / Sargent / Cass
 Aquifer Setting SE Corner North Dakota Longitude/Latitude (optional) 46° 30' N 97° 15' W
 Data Reporting Period *

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells									
			No detections of parameters above MDLs or background levels		No detections of parameters above MDLs or background levels and nitrate concentrations range from background levels to less than or equal to 5 mg/l		Parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs and/or nitrate ranges from greater than 5 to less than or equal to 10 mg/l	Parameters are detected at concentrations exceeding the MCLs	Removed from service	Special treatment	Background parameters exceed MCLs	
			ND	No. of wells in sensitive or vulnerable areas (opt)	ND/Nitrate ≤ 5 mg/l	No. of wells in sensitive or vulnerable areas (opt)						
Ambient Monitoring Network (Optional)	60	VOC	Not sampled for									
		SOC	47	47	18	18	13	0	0	0	0	
		NO ₃	30	30	26	26	3	2	0	0	0	
		Other										
Raw Water Quality Data from Public Water Supply Wells	**	VOC										
		SOC										
		NO ₃										
		Other										
Finished Water Quality Data from Public Water Supply Wells	8	VOC	8	8	0	0	0	0	0	0	0	
		SOC	7	7	0	0	1	0	0	0	0	
		NO ₃	8	8	0	0	0	0	0	0	0	
		Other						0	0	0	0	
Raw Water Quality Data from Private or Unregulated Wells (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Other Sources (Optional)		VOC										
		SOC										
		NO ₃										
		Other										
Major uses of the aquifer or hydrologic unit (Optional)			<input checked="" type="checkbox"/> Public water supply <input checked="" type="checkbox"/> Private water supply		<input checked="" type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input checked="" type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
Uses affected by water quality problems (Optional)			<input type="checkbox"/> Public water supply <input type="checkbox"/> Private water supply		<input type="checkbox"/> Irrigation <input type="checkbox"/> Thermoelectric		<input type="checkbox"/> Commercial <input type="checkbox"/> Livestock		<input type="checkbox"/> Mining <input type="checkbox"/> Industrial		<input type="checkbox"/> Baseflow <input type="checkbox"/> Maintenance	
* Ambient Monitoring: 11/93 - 7/94. Public Water Supply Data: 1993-1995												
** No data available.												

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